December 1954

MECHANICAL ENGINEERING

Problems of the Thermal Barrier 966
Thermal Barrier—Over-All Effects 967
Thermal Barrier—Effects on Systems 970
Thermal Barrier—Effects on Airframes 973

Liquid-Metal-Cooled Reactors . . . . . C. R. Stahl 978

Boiling Heat Transfer:
What Is Known About It . . . . . W. H. Jens 981

Physics . . . Mother of Instrumentation . . . . . G. P. Harnwell 987

Continuous Annealing of Steel Strip—
Controls for a High-Speed Line . . . . . H. C. Morrow 990

The New Atomic-Energy Law—
What It Means to Industry . . . . . E. L. Hollis 995

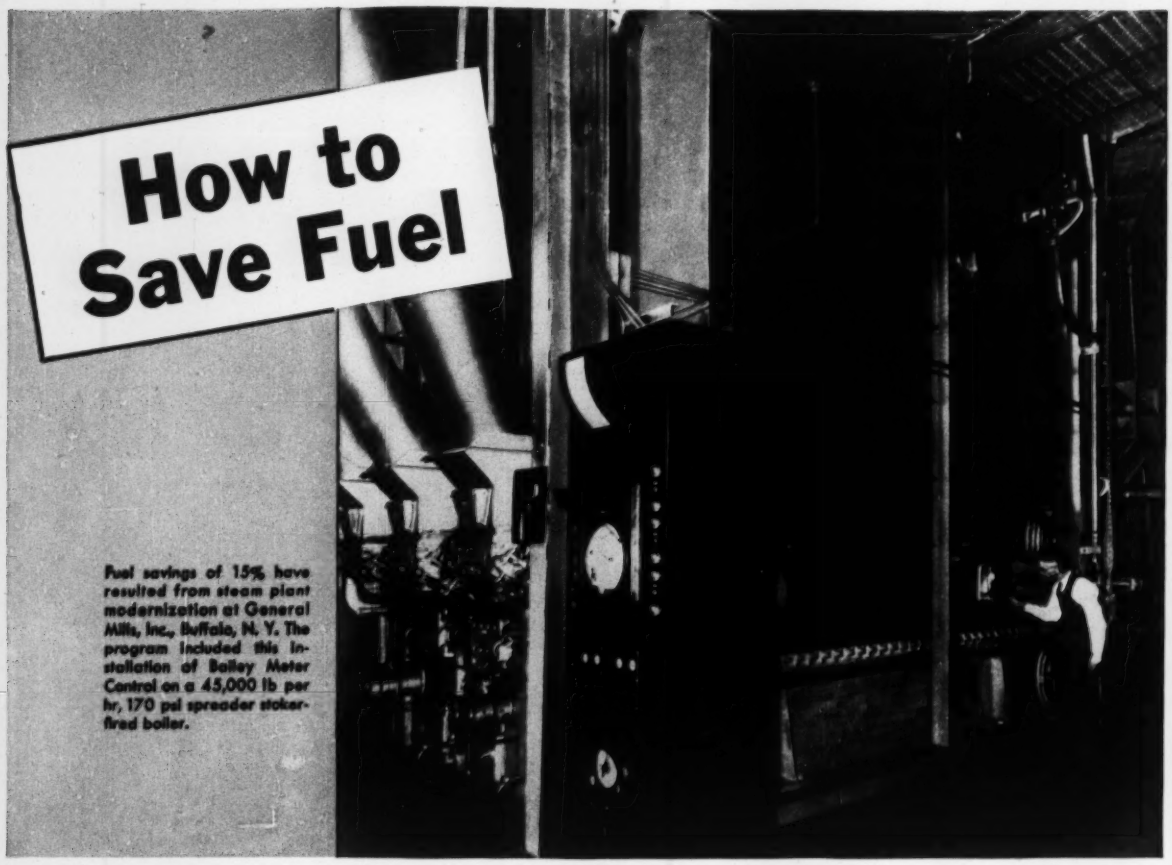
Theory of Maintenance of
Rolling Stock . . . . . R. R. Crane and F. B. Brown 999

Departments

Briefing the Record, 1001
European Survey, 1012
ASME Technical Digest, 1015
ASME News, 1040
Keep Informed, Adv. Page 41

ASME Diamond Jubilee Spring Meeting, Baltimore, Md.
April 18–21, 1955

How to Save Fuel



Fuel savings of 15% have resulted from steam plant modernization at General Mills, Inc., Buffalo, N. Y. The program included this installation of Bailey Meter Control on a 45,000 lb per hr, 170 psi spreader stoker-fired boiler.

● The heat energy you get from a unit of fuel depends on the performance of your steam plant equipment. And that's where Bailey controls can help. With a Bailey-engineered control system you can count on a higher output of available energy per unit of fuel. Here's why:

1. Suitable Equipment

When you receive equipment recommendations from a Bailey Engineer his selections come from a complete line of well-engineered and carefully tested products.

2. Seasoned Engineering Experience

Your local Bailey Engineer brings you seasoned engineering experience based on thousands of successful installations involving problems in measurement, combustion, and automatic control.

3. Direct Sales-Service—close to you

For your convenience and to save time and travel expense there's a Bailey District Office or Resident Engineer in or close to your industrial community.

For greater fuel savings, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're glad to stand on our record. A-121-1

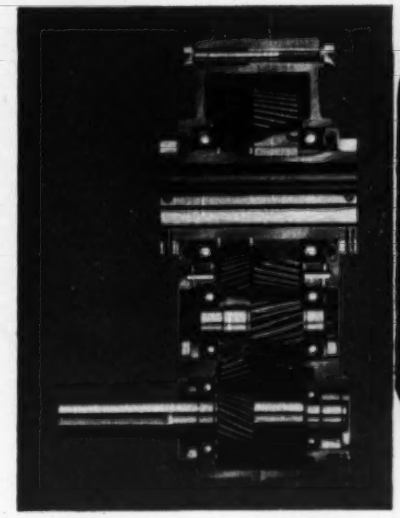
FORMULA
for Cutting Production Costs
•
+ Bailey Design
+ Bailey Engineering
+ Bailey Service
= Greater Savings per Fuel Dollar

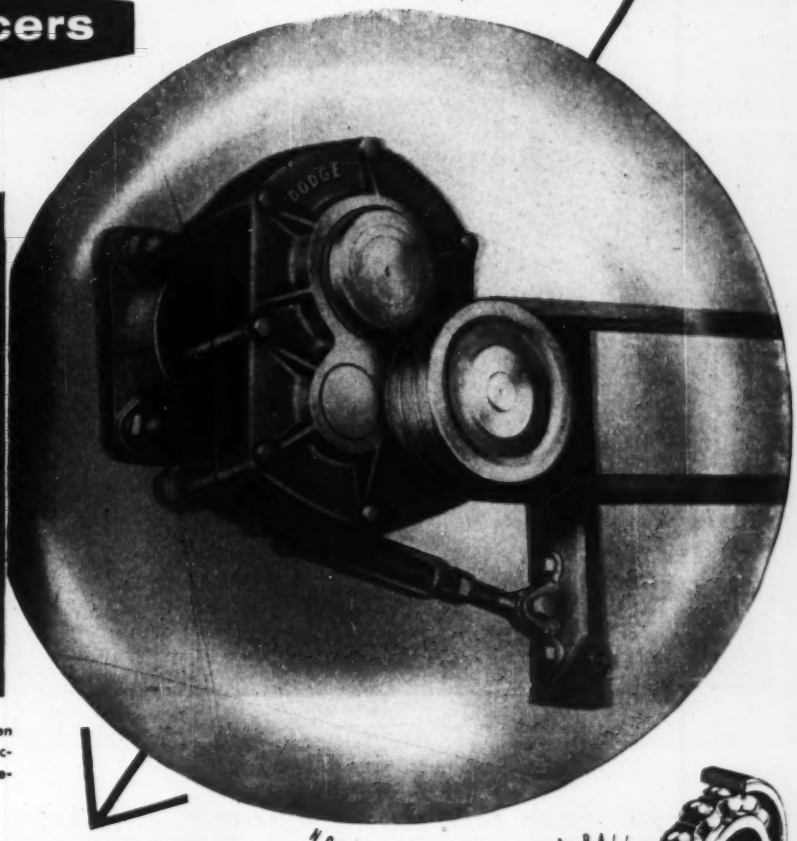
BAILEY

1026 IVANHOE ROAD

Complete Controls for Process Plants

Reducing Costs in Speed Reducers





New Departure ball bearings are used in seven basic sizes of the Dodge single and double reduction speed reducers, handling from 1 to 43 horsepower at output speeds from 12 to 330 r.p.m.

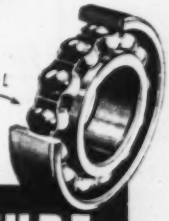
. . . with NEW DEPARTURES

Dodge Manufacturing Corporation's Speed Reducers make good use of design advantages offered by New Departure snap-ring **ball** bearings.

The snap rings locate the bearings in the case, eliminating the need for adjustment. Doing away with threaded or shim-type devices permits straight-through boring of the housing. Thus split-case construction is highly practical, and assembly is greatly simplified. The result is a rigid, highly efficient unit, and one in which production costs have been kept to the minimum.

Learn what New Departure can do for *your* product. Talk with your New Departure sales engineer—*today!*

NOTHING ROLLS LIKE A BALL



NEW DEPARTURE
BALL BEARINGS

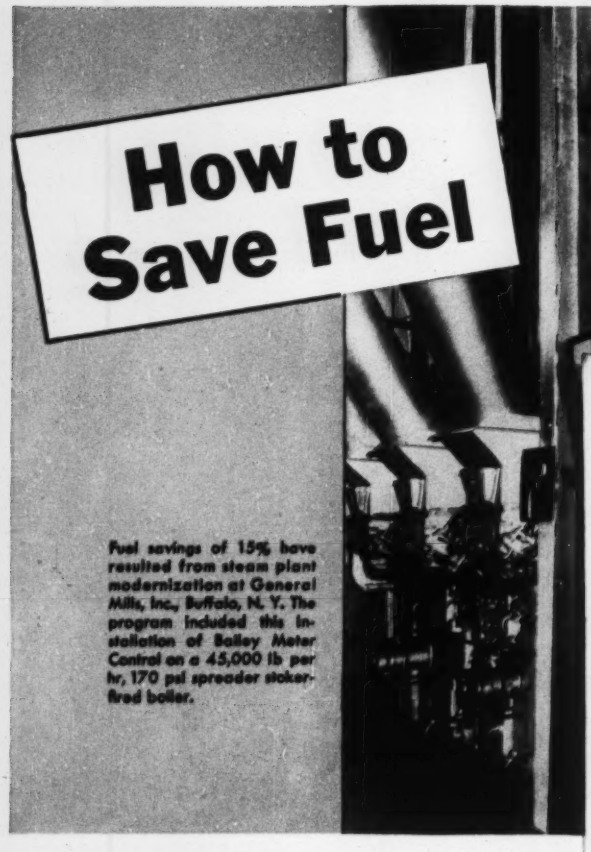
NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
Plants also in Meriden, Connecticut; and Sandusky, Ohio
In Canada: McKinnon Industries, Ltd., St. Catharines, Ontario

NEW DEPARTURE SALES ENGINEERING OFFICES—AT YOUR SERVICE

BRISTOL	269 North Main St.	2-6371	**DETROIT**	7-122 General Motors Bldg.	Trinity 2-4700	**KANSAS CITY**	1021 E. Linwood Blvd.	Valentine 4939
BOSTON	517-A Park Square Bldg.	Hancock 6-9867	**CINCINNATI**	2107 Carew Tower	Main 5783	**MILWAUKEE**	647 W. Virginia St.	Broadway 6-9460
KANNAPOLIS, N. C.	P. O. Box 1086	2-3181	**CLEVELAND**	3113 W. 110th St.	Winston 1-5454	**ST. LOUIS**	3001 Washington Blvd.	Franklin 6533
NEW YORK	1775 Broadway	Circle 6-1540	**INDIANAPOLIS**	1357 W. 18th St.	Imperial 4680	**LOS ANGELES**	5035 Gifford Ave.	Logan 8-2301
PHILADELPHIA	850 E. Luzerne St.	Garfield 3-4136	**PITTSBURGH**	Cathedral Mansions	Mayflower 1-8100	**BERKELEY**	1716 Fourth St.	Landscape 6-8750
SYRACUSE	2360 James St.	73-5195	**CHICAGO**	332 So. Mich. Ave.	Wabash 2-5875	**SEATTLE**	5000 First Ave., S.	Lander 5920
			DAVENPORT	2212 E. 12th St.	Davenport 7-7522			

MECHANICAL ENGINEERING, December, 1954, Vol. 76, No. 12. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations

How to Save Fuel



Fuel savings of 15% have resulted from steam plant modernization at General Mills, Inc., Buffalo, N. Y. The program included this installation of Bailey Meter Control on a 45,000 lb per hr, 170 psi spreader stoker-fired boiler.

WA
PAG

● The heat energy you get from a unit of fuel depends on the performance of your steam plant equipment. And that's where Bailey controls can help. With a Bailey-engineered control system you can count on a higher output of available energy per unit of fuel. Here's why:

1. Suitable Equipment

When you receive equipment recommendations from a Bailey Engineer his selections come from a complete line of well-engineered and carefully tested products.

2. Seasoned Engineering Experience

Your local Bailey Engineer brings you seasoned engineering conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're glad to stand on our record.

A-121-1

FORMULA
for Cutting
Production Costs
•
+ Bailey Design
+ Bailey Engineering
+ Bailey Service
= Greater Savings
per Fuel Dollar

BAILEY

1026 IVANHOE ROAD

Complete Controls for Process Plants

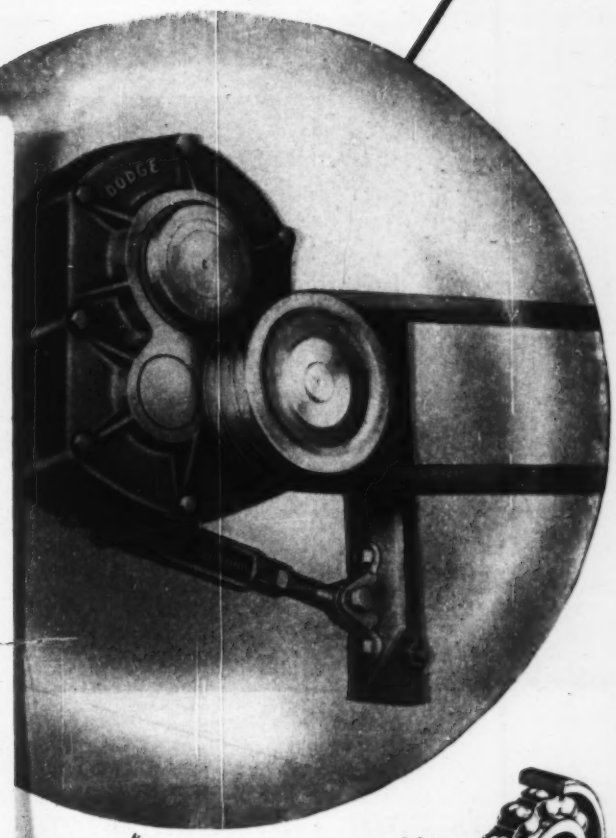
Reducing Costs

In

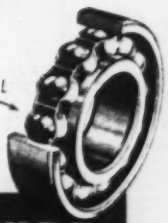
Speed Reducers

AVY

iES



NOTHING ROLLS LIKE A BALL



make good use of design advantages offered by New Departure snap-ring **ball** bearings.

The snap rings locate the bearings in the case, eliminating the need for adjustment. Doing away with threaded or shim-type devices permits straight-through boring of the housing. Thus split-case construction is highly practical, and assembly is greatly simplified. The result is a rigid, highly efficient unit, and one in which production costs have been kept to the minimum.

Learn what New Departure can do for *your* product. Talk with your New Departure sales engineer—*today!*

NEW DEPARTURE

BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

Plants also in Meriden, Connecticut, and Sandusky, Ohio

In Canada: McKinnon Industries, Ltd., St. Catharines, Ontario

NEW DEPARTURE SALES ENGINEERING OFFICES—AT YOUR SERVICE

BRISTOL	269 North Main St.	2-6371	**DETROIT**	7-122 General Motors Bldg.	Trinity 2-4700	**KANSAS CITY**	1021 E. Linwood Blvd.	Valentine 4939
BOSTON	517-A Park Square Bldg.	Hancock 6-9867	**CINCINNATI**	2107 Carew Tower	Main 5783	**MILWAUKEE**	647 W. Virginia St.	Broadway 6-9460
KANNAPOLIS, N. C.	P. O. Box 1086	2-3181	**CLEVELAND**	3113 W. 110th St.	Winston 1-5454	**ST. LOUIS**	3001 Washington Blvd.	Franklin 6533
NEW YORK	1775 Broadway	Circle 6-1540	**INDIANAPOLIS**	1357 W. 18th St.	Imperial 4680	**LOS ANGELES**	5035 Gifford Ave.	Logan 8-2301
PHILADELPHIA	850 E. Luzerne St.	Garfield 3-4136	**PITTSBURGH**	Cathedral Mansions	Mayflower 1-8100	**BERKELEY**	1716 Fourth St.	Landscape 6-8750
SYRACUSE	2360 James St.	73-5195	**CHICAGO**	332 So. Mich. Ave.	Wabash 2-5875	**SEATTLE**	5000 First Ave., S.	Lander 5920
			DAVENPORT	2212 E. 12th St.	Davenport 7-7522			

MECHANICAL ENGINEERING, December, 1954, Vol. 76, No. 12. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations

Meet the man you can call with confidence to solve your thermal insulation problems

To insulate outdoor tanks with complete weather protection, these skilled J-M applicators follow a specification developed by Johns-Manville. Here they are fastening J-M Asbestocite* Sheets over J-M Zerolite* Insulation. J-M 85% Magnesia Insulation is also widely used for this type of equipment

He is your J-M Insulation Contractor... the man with the world's most complete insulation engineering service

"Insulation is no better than the man who applies it." Today, with rising fuel and maintenance costs, it is especially important to place your insulation job in skilled hands. The scientific application of J-M quality insulations by J-M Insulation Contractors will assure you of the maximum return on your insulation investment for years to come. Moreover, you get undivided responsibility for *all* your insulation requirements.

1. You get dependable materials—Johns-Manville manufactures a complete line of insulations for every service temperature from minus 400F to plus 3000F. From them your J-M Insulation Contractor can select the right insulation for the most dependable service on your job. To develop new and improved insulation materials Johns-Manville maintains the J-M Research Center—largest laboratory of its kind in the world.

2. You get dependable engineering—For 95 years Johns-Manville has been accumulating insulation engineering experience. J-M Insulation Engineers are called upon to solve insulation problems of every type and magnitude, in every industry. Since your J-M Insulation Contractor works closely with J-M Insulation Engineers, he brings to *every* job a high degree of training, skill and experience.

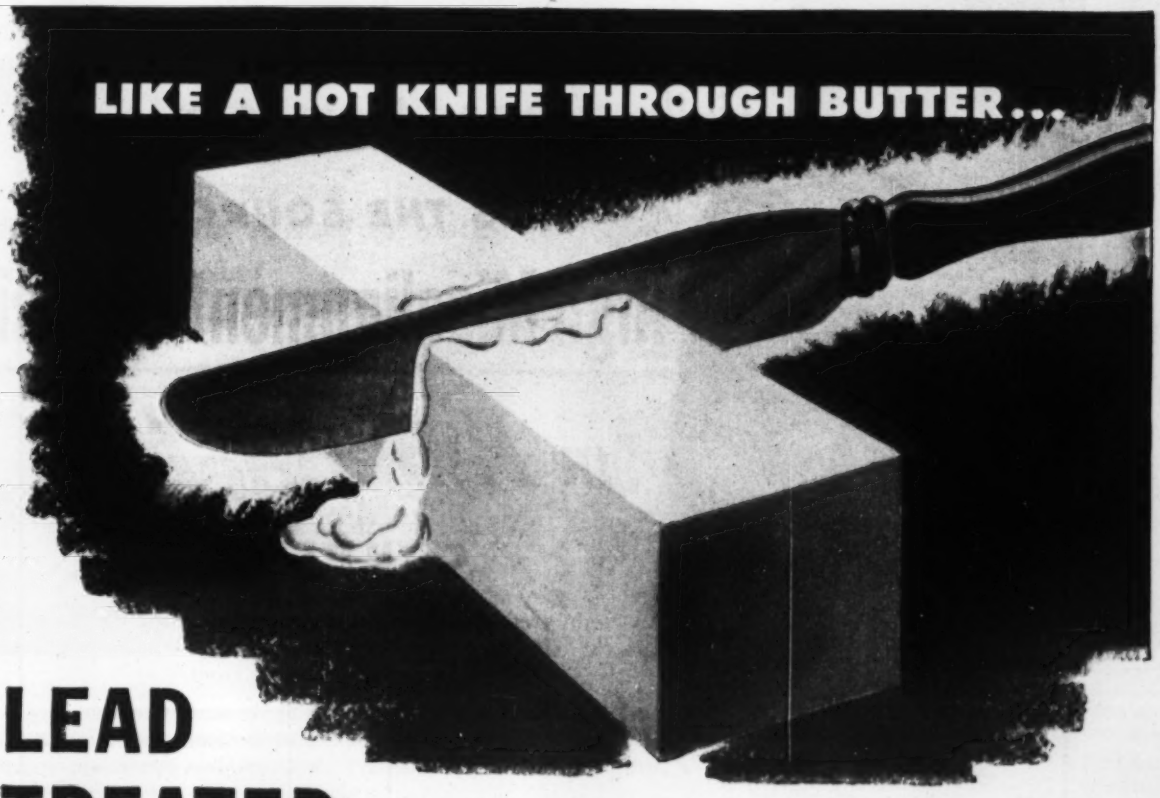
3. You get dependable application—Johns-Manville has set up a nationwide organization of J-M Insulation Contractors to serve you. These Contractors maintain staffs of insulation engineers as well as skilled mechanics thoroughly trained in J-M's proved application methods. You can have absolute confidence in their ability to apply J-M insulations correctly for trouble-free performance.

For further information and the name of your J-M Insulation Contractor, write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

*Reg. U. S. Pat. Off.

Johns-Manville *FIRST IN* INSULATION

MATERIALS • ENGINEERING • APPLICATION



LEAD TREATED ARISTOLOY *CUTS CLEAN AND FAST*

"Machine tool production increased 35 to as much as 75 per cent"—users of leaded steels report. The addition of lead acts as a lubricant reducing friction between chip and tool. The beneficial results—faster machining speeds—much longer tool life—and vastly improved product finish. With normal heat treating, mechanical properties such as yield strength, tensile strength and ductility are unaffected.

You can obtain similar manufacturing benefits by specifying Aristoloy *leaded* alloy or Ledloy* (leaded) carbon grades. Available in all A.I.S.I. or S.A.E. standard analyses—write or call today for information about application of free cutting leaded steels to your products.

*Inland Ledloy License

DISTRICT OFFICES

P. O. Box 1633
Tulsa, Oklahoma

315 Hollenbeck Street
Rochester, New York

117 Liberty Street
New York, New York

711 Prudential Building
Houston 25, Texas

80 King Street West
Toronto, Ontario, Canada

Monadnock Building
San Francisco 5, Calif.

325 W. 17th Street
Los Angeles 15, Calif.

First National Bank Bldg.
Jamestown, New York

1578 Union Commerce Bldg.
Cleveland, Ohio

176 W. Adams Street
Chicago, Illinois

1807 Elmwood Avenue
Buffalo, New York

7251 General Motors Bldg.
Detroit, Michigan

143 Washington Avenue
Albany, New York

611 Beury Building
Philadelphia 40, Penna.

625 James Street
Syracuse, New York

3102 Smith Tower
Seattle, Washington

ARISTOLOY STEELS

COPPERWELD STEEL COMPANY

(STEEL DIVISION) WARREN, OHIO

For export—Copperweld Steel International Company, 117 Liberty Street, New York

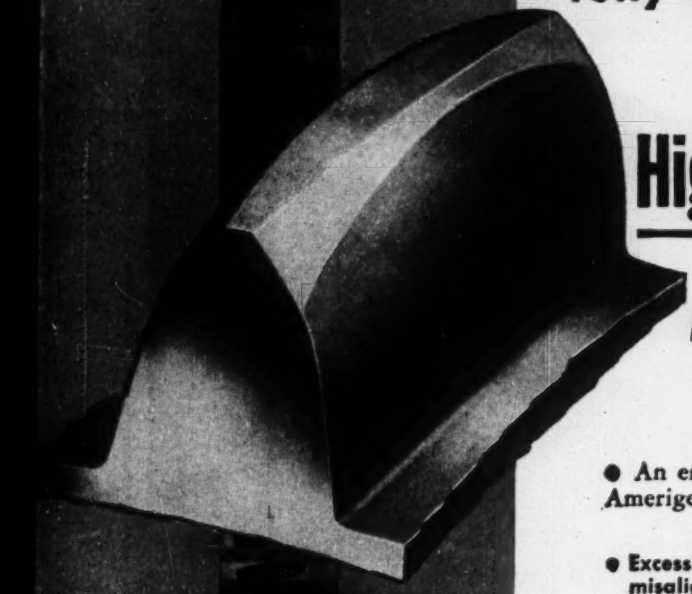
The Amerigear® patented fully crowned tooth form...

...IS THE SOURCE OF

High Misalignment Capacity*

IN Amerigear®

COUPLINGS

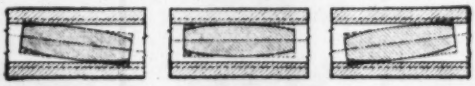


Illustrating Full Cycle Misalignment Pattern of Amerigear H.M.C.* Patented Tooth Form.

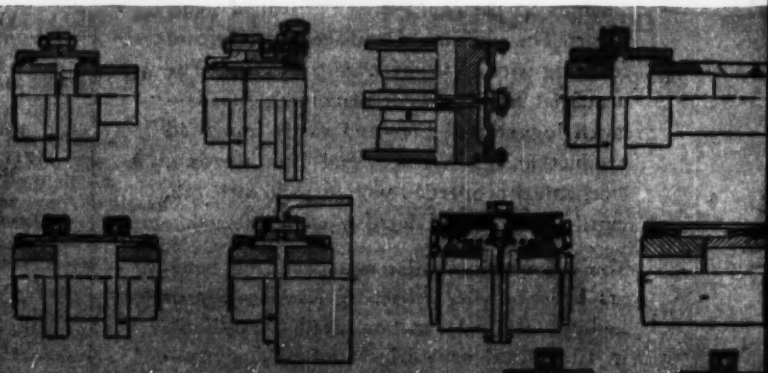
● An engineered application, using advantages of the Patented Amerigear HMC* Flexible Coupling, can solve any power transmission problem arising from:

- **Excessive lateral and angular misalignments;**
- **Tight backlash requirements;**
- **Space limitations;**
- **High speeds and loads;**
- **Continuous operation;**

or any combination of these



Comparison with gearing of conventional gear-type couplings shows how Patented Amerigear Tooth Form eliminates *tooth end loading* and simultaneously allows for both lateral and angular misalignment. Dotted lines indicate gear teeth of conventional gear couplings.



A few of many types of Amerigear Flexible Couplings that have been derived from Standard Type Amerigear Couplings by engineering applications to utilize the advantages of the Patented Amerigear Fully Crowned Tooth Form. Write for Catalog 531 and Bulletin 1952 which illustrate several special types, or attach coupon to business letterhead.

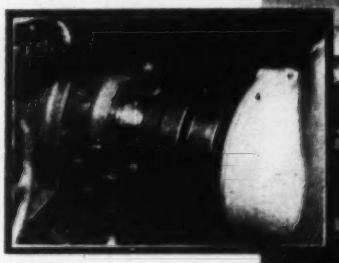
Amerigear® HMC* FLEXIBLE COUPL

One of several standard types embodying the Pat Amerigear Tooth Form

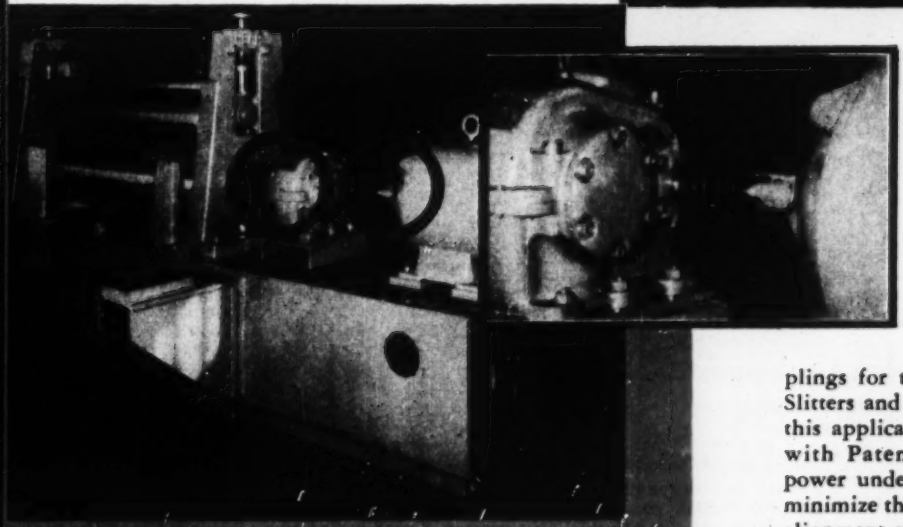
Patented and Patents Pending

Amerigear® HIGH MISALIGNMENT CAPACITY* COUPLINGS

Solve power transmission problems for wide variety of metal working equipment!



In this application a Standard Type of Amerigear HMC* Coupling is a vital part of the pump and motor drive units on a 350-ton capacity Bliss Hydro-Dynamic Hot Nosing Press. The pump and motor drive unit operating at 1200 r.p.m. provides hydraulic pressure to operate the press ram. Every 10 seconds the operating load transmitted increases from 125 h.p. to 150 h.p. and is held for approximately 2 seconds—thus, the load being transmitted fluctuates several times per minute. There are two pump and motor drive units on this press. This is a typical example of how a Standard Type Amerigear HMC* Coupling is utilized to solve power transmission problems arising from a fluctuating load, tight backlash requirement, space limitation, and lateral and angular misalignment conditions.



One of several applications of Standard Type Amerigear HMC* Couplings installed on Pinch Rolls manufactured by Herr Engineering Company. In this application two Amerigear HMC* Couplings are used; one on the rotating shaft between the motor and the gear reducer, and another between the gear reducer and the roll end. Herr Engineering also use Standard Types of Amerigear HMC* Couplings for their Pay-off Reels, Take-up Reels, Slitters and other steel finishing equipment. In this application Amerigear HMC* Couplings with Patented Tooth Form are transmitting power under shock loading conditions. They minimize the effect of any lateral or angular misalignment which may occur, thereby reducing maintenance costs to an all-time low.

Copyright 1954

Amerigear Engineers are available to assist in *engineering special applications* of the Amerigear Patented Crowned Tooth Form and for adapting Amerigear Standard Type HMC* Couplings to solve your power transmission problems. Write for Catalog 501 and Bulletin 1052, or attach coupon to your business letterhead.

AMERICAN FLEXIBLE COUPLING COMPANY

ERIE, PA., U. S. A.

Affiliate: J. A. Zurn Mfg. Co.

ZURN

SALES OFFICES IN PRINCIPAL CITIES OF THE WORLD

In Canada: Canadian Zurn Engineering Ltd., 2052 St. Catherine St. W., Montreal 23, P. Q.

Dept. ME 619

AMERICAN FLEXIBLE COUPLING CO. • Erie, Pa., U.S.A.

Please send me further information regarding AMERIGEAR COUPLINGS with the Patented Fully Crowned Tooth Form as described in Catalog No. 501 and Bulletin 1052.

Name ..... *Title* .....

Company .....

Address .....

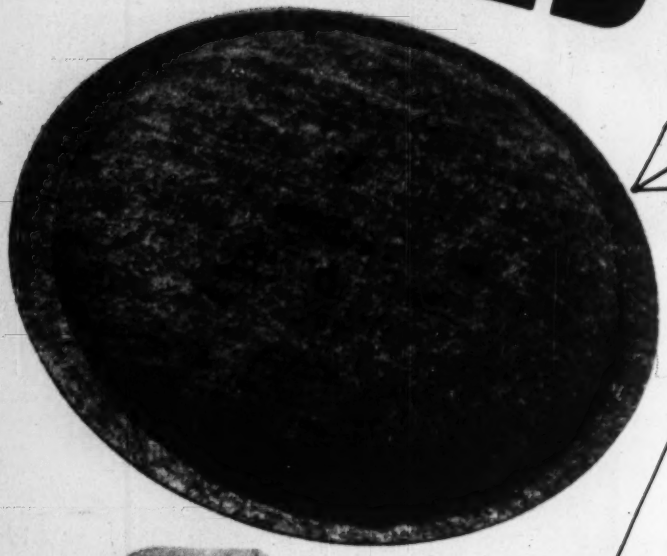
City ..... *Zone* ..... *State* .....

Please attach to your business letterhead.

SCIENCE MAKES POSSIBLE

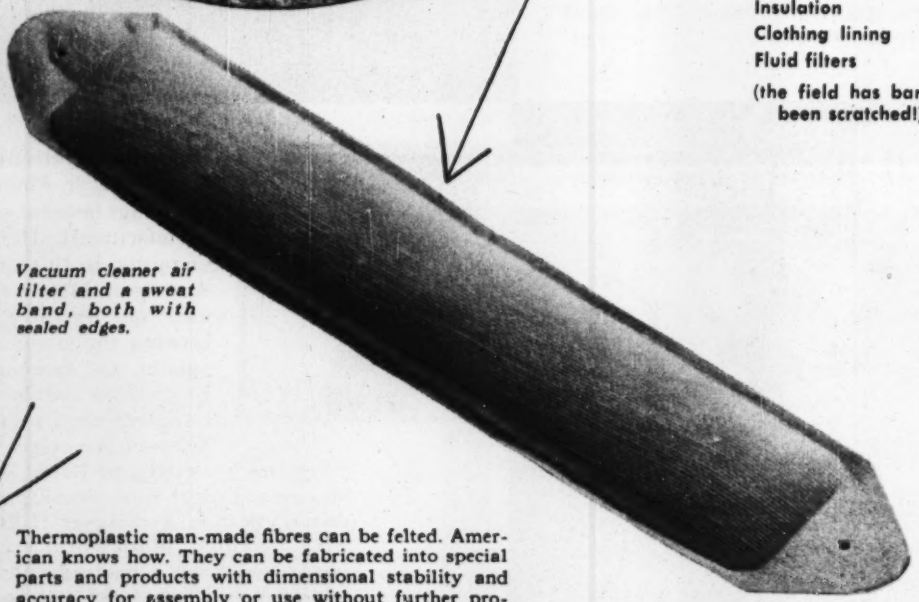
FUSED EDGES

U.S. Pats. 2521984 2521985



Some Present Uses

Dust shields
Vacuum cleaner filters
Powdered soap containers
Face powder pads
Insulation
Clothing lining
Fluid filters
(the field has barely been scratched!)



Vacuum cleaner air filter and a sweat band, both with sealed edges.

Thermoplastic man-made fibres can be felted. American knows how. They can be fabricated into special parts and products with dimensional stability and accuracy for assembly or use without further processing. If desired, fused edge products can be joined to other fabrics instead of by the conventional methods of stitching, adhesives or clamping. The felt within the edges can have any desired porosity, or density characteristics, within wide limits, since such felts can be made entirely of manufactured fibres, or contain mixtures of natural and man-made fibres. Thus these fused-edge felts have great versatility, and are capable of rendering many different services. It will pay you to look into what fused-edge felt products and parts can do for you. Write for information on your company letterhead.

AmericanFelt Company

TRADE MARK

50 GLENVILLE RD. GLENVILLE, CONN.

MORE *GO* FOR YOUR MONEY

Designed and engineered to be the finest you can buy, Aetna bearings and parts give you real economy through highest quality . . . help your products deliver more "go," more efficiency, longer life, greater satisfaction to the user. Choose from our complete line of standard ball thrust bearings (catalog on request) or send us your blueprints if your requirements involve special bearings or hard-to-make precision parts. Engineering assistance, experimental work and quotations promptly rendered without obligation.

Aetna

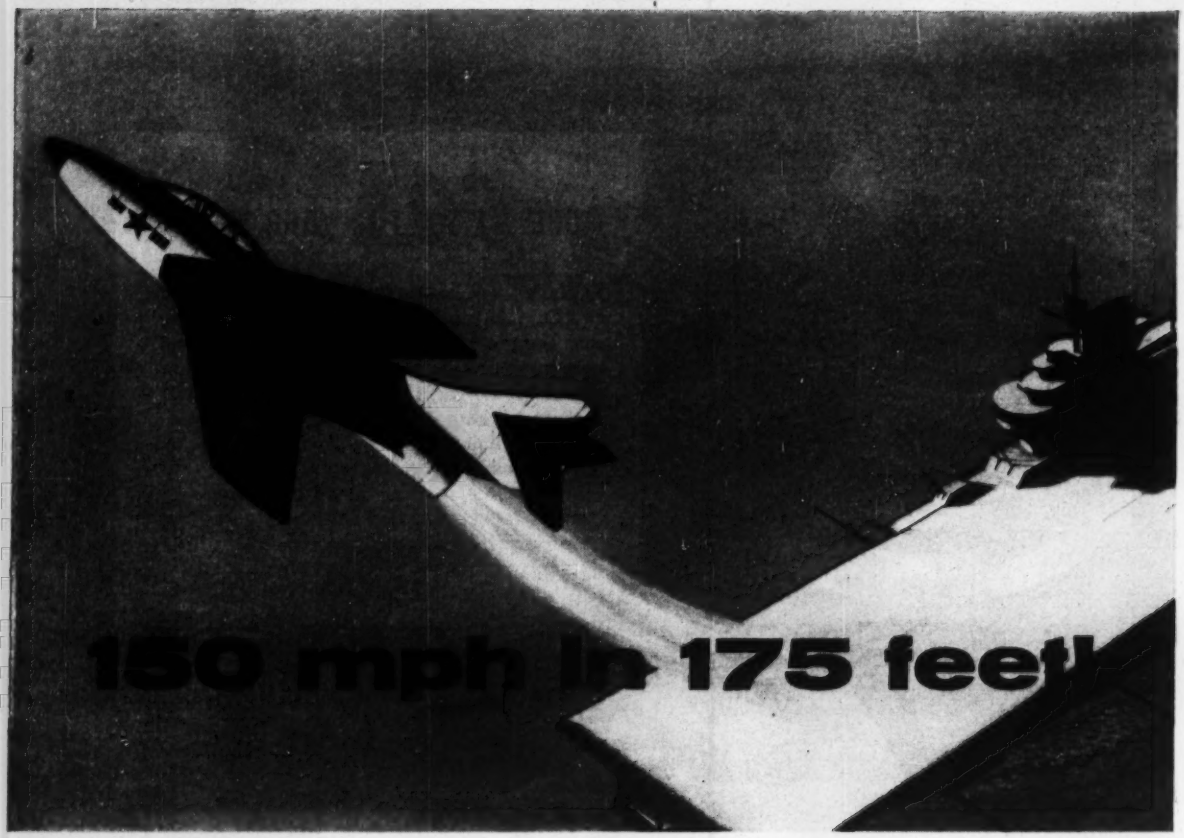
AETNA BALL AND ROLLER BEARING COMPANY

DIVISION OF PARKERSBURG-AETNA CORPORATION

4600 Schubert Avenue • Chicago 39, Illinois

In Detroit — Sam T. Keller — 2457 Woodward Avenue

Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Precision Parts



That is the speed at which the latest steam catapult launches a jet fighter. Such speed requires precision and split-second action to control the temperature and pressure of the steam which drives the catapult. Hagan Automatic Control has been chosen for this important function.

This is just one of the many specialized applications for which versatile Hagan control systems are ideally suited. A few recent applications of Hagan Automatic Control to aeronautical and automotive test facilities are listed below.

- Automatic control systems for subsonic and supersonic wind tunnels.
- Automatic control systems for accessory and component test facilities.
- Automatic control systems for steady state, blowdown and trajectory tests in turbojet, turboprop and ram jet test facilities.
- Automatic control systems for burner stands.
- Automatic control systems for parallel and/or series operation of blowers and exhausters.
- Programmed control systems for simulated flight conditions and trajectory tests.
- Automatic controls for gas turbines.
- Automatic control of pressure, pressure ratio, temperature and mass flow.
- Direct reading mass flow meters for both air and fuel, with automatic correction for variable pressure, temperature and density.
- Automatic resolution of multiple wide range correction factors into a single correcting signal.
- Measurement and control of gas flow, with automatic correction for pressure and temperature variation.
- Jet engine and rocket thrust measurement.
- Portable thrust stands for aircraft thrust measurement.

HAGAN CORPORATION

HAGAN BUILDING. PITTSBURGH 30, PENNA.

AERONAUTICAL AND SPECIAL PRODUCTS DIVISION

HAGAN HALL BUROMIN CALGON

NEW "Small" boiler is a Big Quality package!

Available up to 150 hp — heating or processing — steam or hot water. A complete unit from a single source.

CLEAVER-BROOKS modern C-B boiler

NO BOILER HAS EVER OFFERED SO MANY ADVANTAGES AND QUALITY FEATURES AT SUCH LOW INITIAL COST

• This NEW CB boiler has EVERYTHING needed to bring *big boiler standards* to commercial, industrial and institutional users with small capacity requirements. Despite its unusual, compact size you get big boiler performance — from matched-quality components, proved the world over on thousands of Cleaver-Brooks self-contained units.

Get all the facts NOW on how the new CB can help you save dollars. Make it a point to see . . . and *hear* the most silent-running, biggest boiler value available anywhere!

•

Call your nearest CB boiler representative (see your phone directory) or send for this illustrated catalog describing the NEW CB — designed by Cleaver-Brooks, originators of self-contained boilers.

gives you all the quality features of time-tested self-contained design

- **FOUR-PASS FIRETUBE CONSTRUCTION** — longer gas travel scrubs heat from flame — means lower fuel costs — guaranteed efficiency of 80% when firing with oil.
- **SILENT OPERATION** — even at peak load this boiler more than meets the low sound levels required for schools, hospitals, institutions.
- **FULL FIVE SQUARE FEET** — of heating surface per boiler hp — for longer service life and low maintenance.
- **FUEL FLEXIBILITY** — burns available light oil, gas, or combination oil/gas — simple, quick fuel changeover on oil/gas models.
- **FAST, EASY MAINTENANCE** — front and rear doors hinged for fast inspection, cleaning or servicing boiler.
- **AUTOMATIC SAFE OPERATION** — all controls centralized and conveniently located — modern electronic combustion control is standard equipment.
- **COOLER BOILER ROOM** — fiber glass blanket insulation and 16 gauge metal sectional lagging are non-corrosive, moisture and heat resistant.
- **FULLY APPROVED** — by Underwriter Laboratories; conforms to ASME codes; factory tested before shipment.

NOW—FIRST SIZES OF THE CB BOILERS ARE MADE IN CANADA, TOO.

Cleaver Brooks

Cleaver-Brooks Company, Dept. P, 319 E. Keefe Ave., Milwaukee 12, Wisconsin, U.S.A.
Cable Address: CLEBRO — Milwaukee — All Codes.

Originators of the Self-Contained Boiler

can this "UNUSUAL GROUP" *solve your toughest technical problem?*

IT COSTS NOTHING TO FIND OUT. And in the process, you'll learn why this group has satisfied hundreds of clients, large and small.

WHAT IS THE GROUP? This is the Design and Development Group of the Mechanical Division of Arthur D. Little, Inc. . . . one of many successful working units into which ADL's scientists, engineers and technologists are grouped. With its handpicked members, it typifies the integrated thinking and practical attack to industrial research problems which have made ADL a leader in diversified research and development.

Each member of this ingenious group is expert in a different field; yet, all are alike in their grasp of the fundamentals of good engineering. They know how to get new functions out of old principles. You'll know them by name before your initial conference with them is over.

HOW DO THEY WORK? First, a group meeting studies your problem from every angle to determine what it can do toward the solution. A proposal comes next, outlining the approach . . . tells you how much time and money are involved. Only when you say "go ahead" do you pay a cent.

At this point a project leader takes over. Depending on the scope of your project he works singly, or with a group, but always supplemented by the specific practical experience and general knowledge of the entire ADL staff. The size of this team and the range of your problem determine the cost.

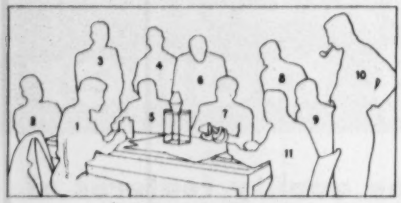
YOU'RE IN CHARGE! You have as close control over your ADL project team as if its members were working in your own plant. The range of ADL work on the project is up to you: concept, sketch, mock-up, detailed production drawings, prototype or complete processing equipment.

WHY DELAY? If you feel that new or improved equipment, products, and methods can increase your profits, investigate what an ADL group can do for you. For detailed information or preliminary discussion phone UNiversity 4-5770 (Boston) or write:

ARTHUR D. LITTLE, INC., MECHANICAL DIVISION
37 MEMORIAL DRIVE, CAMBRIDGE 42, MASS.

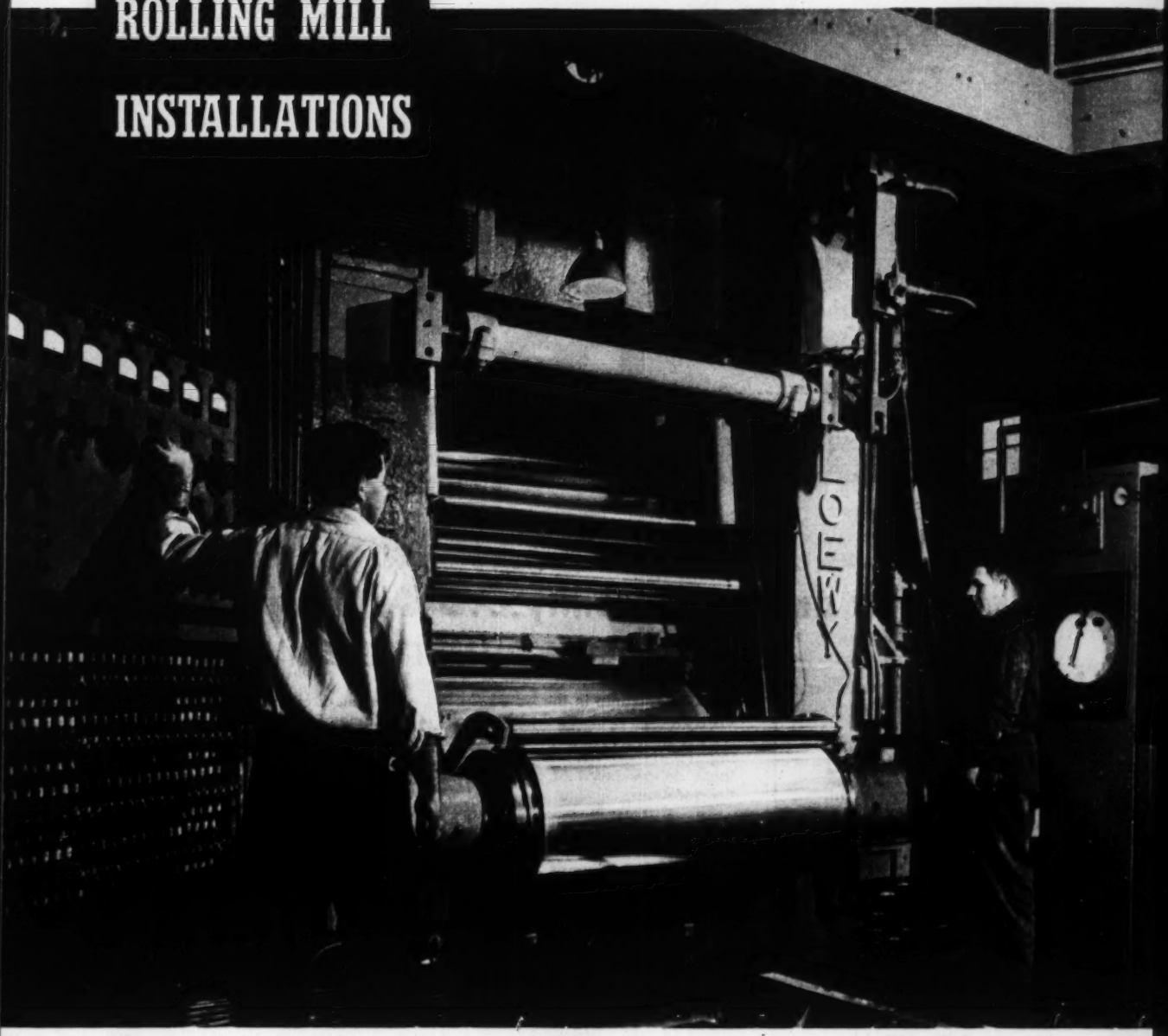
MECHANICAL DESIGN AND DEVELOPMENT GROUP

1–Automatic Control and Metals Engineering . . . 2–Sonic and Mechanical Engineering . . 3–Turbine, Compressor, and Power Machinery Engineering . . . 4–Machine Design and Thermodynamics . . . 5–Electrical and Mechanical Engineering . . . 6–Aeronautical Engineering and Mechanical Design . . . 7–Medical and Mechanical Engineering (Group Leader) . . . 8–Mechanical Design and Plant Engineering . . . 9–Process and Development Engineering . . . 10–Electronic and Mechanical Engineering . . . 11–Tool and Die Engineering; Production Machine Design.



WE BUILD COMPLETE ROLLING MILL INSTALLATIONS

THREE-HIGH OR TWO-HIGH BLOOMING MILLS • SKELP ROLLING MILLS
CONTINUOUS BILLET AND SHEET BAR MILLS • CONTINUOUS STRIP MILLS
HIGH SPEED COLD ROLLING SHEET AND STRIP MILLS • SPECIAL MILLS
CONTINUOUS MERCHANT AND WIRE-ROD MILLS • MERCHANT MILLS
RAIL AND STRUCTURAL MILLS • HIGH SPEED FOIL MILLS



"Aluminum . . . Foil up to 54 inches wide—the widest made in the West and equal to the widest produced in the Nation—is produced by the plant's new Four-High 60-inch Mill . . . increases the plant's rated annual capacity from 12 million pounds per year to 18 million, a boost of 50 per cent, and permits the Corporation to keep pace with the mushrooming demand for wide foil . . . Can reduce aluminum in thickness from .026 of an inch to .00025 of an inch and operates at speeds up to 3,000 feet per minute . . ."

KAISER ALUMINUM & CHEMICAL CORP.

DESIGNED AND BUILT BY

LOEWY HYDROPRESS INC

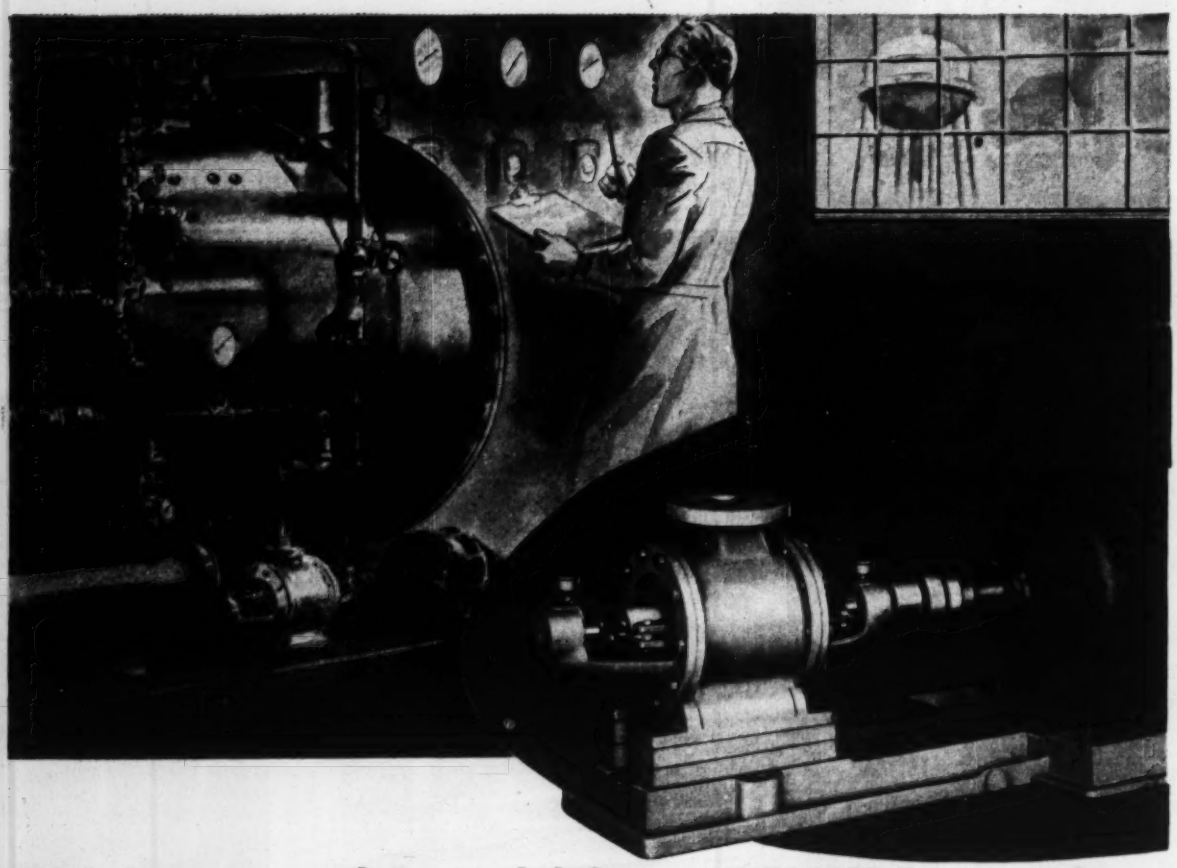
LOEWY-HYDROPRESS NEW YORK, N.Y.

ROLLING MILL DIVISION

ENGINEERS • CONTRACTORS

350-M Fifth Avenue, NEW YORK 1, N. Y.

Rolling Mills • Hydraulic Presses • Pipe Testing Machines • Special Pipe Mill Equipment • Accumulators • Pumps • Die Casting Machines



ADD Economy and Dependability . . . *DEDUCT* Costs with—
MODERN PUMPING EQUIPMENT

DUDCO DIVISION
Hazel Park, Mich.
Dual-Vane Hydraulic Pumps, 3 to 120 gpm; Fluid Motors, 7 to 140 hp; 2000 psi operation. Piston-Type Pumps for 5000 psi.

HYDRECO DIVISION
Cleveland, Ohio
Gear-Type Hydraulic Pumps, 3 to 120 gpm; Fluid Motors, 3 to 52 hp; Cylinders; Control and Auxiliary Valves; 1500 psi.

WATERTOWN DIVISION
Watertown, N. Y.
Railroad air brake valves for freight and passenger equipment, STRATOPOWER Hydraulic Pumps for Aircraft, to 3000 psi.

KINNEY MANUFACTURING DIVISION
Boston, Mass.
Rotating Plunger and Heliquad Liquid Handling Pumps, to 3000 gpm. Vacuum Pumps, 0.2 micron, evacuate 1800 cfm.

AURORA PUMP DIVISION
Aurora, Ill.
Liquid Handling Pumps, Centrifugals, 4000 gpm, 500 ft. heads. Turbine-Types, 7000 gpm. Condensate Return Units.

From the sump in the basement to the water tower above the plant, your Liquid Handling Equipment is moving *dollars* as well as water. Are these dollars profit or loss? That is the question!

The Aurora Pump and Kinney Manufacturing Divisions of The New York Air Brake Company provide industry with the Pumps to modernize all Liquid Handling installations. For plant water systems; for sump, boiler feed, condensate return, refrigeration, air conditioning and drainage . . . Aurora and Apco Turbine and Centrifugal Pumps bring important economies to every problem of water transfer. These pumps cover a broad range of capacities, pressures, configurations and choice of drivec. In many cases, they perform special services in the processing of beverages, chemicals, acids and the transfer of gasoline and oil.

Kinney Pumps, in Rotating Plunger and Heliquad Gear types, have a well established reputation of being able to *"move anything that will flow through a pipe"*. They are the economical answer to the processing of sludges, slurries, asphalt, bunker fuel, waxes, molasses and other viscous or semi-solid substances.

For Vacuum Processing, the new developments in Kinney High Vacuum Pumps afford added opportunities for savings in production costs.

A fourth, and equally interesting, opportunity to increase productivity and reduce costs is found in the Fluid Power facilities of the Dudco, Hydreco and Watertown Divisions of The New York Air Brake Company.

Look to YOUR Pumps! They represent one of the most important areas for savings in the modern plant.

Literature fully describing these modern Liquid Handling, Vacuum Processing and Fluid Power pumps, as well as Air Brake's exceptional facilities for precision sub-contract work, is yours for the asking. Write for it today!

THE NEW YORK AIR BRAKE COMPANY

230 PARK AVENUE • NEW YORK 17, N. Y.

The modern way is the WeldELL® way

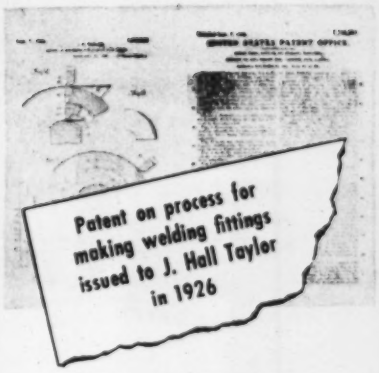
Naturally the organization that developed the first complete line of welding fittings has remained first...in design...in breadth of types, weights, sizes and materials.

That is why those who have followed the development of the WeldELL line, usually refuse to consider any other type of welding fittings.

See your Taylor Forge Distributor for up-to-the-minute facts.

TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS • General Offices and Works: P.O. Box 485, Chicago 90, Illinois • Offices in all principal cities Plants at: Carnegie, Pa.; Fontana, Calif.; Gary, Ind.; Hamilton, Ontario, Canada



The formula was written in 1926—

The invention of oxyacetylene and electric arc welding touched off the greatest single advance in modern piping practice—pipe welding.

The old way—the screwed fittings and heavy flanged fittings—put up a brave fight, but the handwriting was on the wall! For all important piping the old method was through.

Proof that Taylor Forge had foreseen this clear back in 1926 is shown above. Significantly enough, the process covered by this patent is still employed to give WeldELLS certain advantages not found in any other welding fittings.

But Taylor Forge experience had suggested careful procedure — had foreseen that pipe welding could not advance beyond its crude, torch-happy stage until *all* necessary fittings were provided to make *complete* welded systems.

It took a number of years to do this job with Taylor Forge thoroughness, but in 1931 the announcement was made of the first complete line of seamless butt welding fittings — the first line to include not only elbows and return bends, but also full branch and reducing tees, concentric and eccentric reducers, stub ends, caps, and the all-important (and then revolutionary) welding neck flanges.

Out of 31 years of designed piping experience had come the greatest contribution to piping permanence.

An episode in the story of Taylor Forge leadership in designed piping

TF

TERRY

PROTECTION OF TURBINE BLADES made possible by nozzle location

The Terry Solid-wheel Turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.

In the Terry Solid-wheel Turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.

The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

This is only one of the many important features of the Terry Solid-wheel Turbine. Write for complete details.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1195

Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

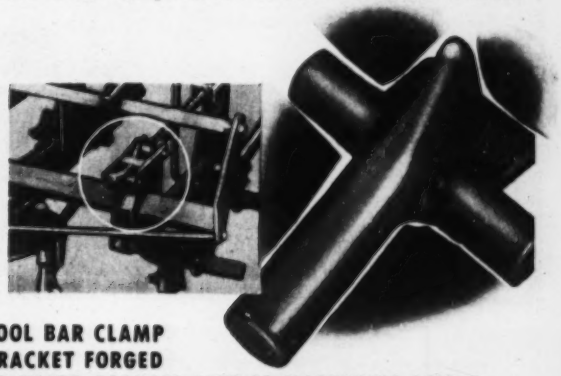
USE MORE FORGINGS

get more Cost Reductions at the point of assembly

A thorough "going-over" of each part of a product or mechanism to consider whether it can be or should be more efficiently produced will inevitably yield some worthwhile reductions in cost at the point of assembly. This process of examining each component may be accomplished in less time and with less effort than would first appear with the aid of Drop Forging "Problem Parts Charts" for design engineers, production executives, metallurgists and purchasing agents. These charts utilized along with the experienced skill of a forging engineer working with one or more members of a production team often reveal cost reducing possibilities heretofore undiscovered. Ask a forging engineer for a complete set of Problem Parts Charts.

STRONG, TOUGH, DENSE FORGED PARTS CUT REJECTIONS 26.4% FOR MANUFACTURER OF A VARIETY OF QUARRYING AND MINING EQUIPMENT

These drilling machine parts are closed die forgings, used to obtain greater strength, reduction of dead weight, better physical properties, and reduction in percentage of rejects to a minimum.

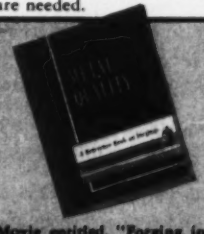


TOOL BAR CLAMP BRACKET FORGED TO SHAPE, REDUCES COST OF MACHINING 12%

Key part of trigger latch for tractor-mounted cultivator, formerly a three-piece welded assembly built up from bar stock, now closed die forged in one piece. Results in increase of approximately 60% in number of parts completed per hour. Forging eliminates all but a simple drilling operation—no jigs, assembly or welding operations are needed.

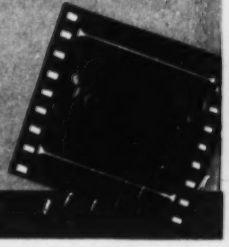
PARTS FOR LOCOMOTIVE GREASE GUNS PRODUCED 68% FASTER BY CLOSED DIE FORGING

Manufacturer of "Spee-d" High Pressure Lubricating Units uses closed die forgings for gun handles, links, nozzle connections, bodies and engaging rings, and thereby obtains such advantages as greater strength and uniformity of physical properties, reduction in dead weight, and a 68% increase per hour in the production of finished parts.



This book tells why forgings are used for the toughest work loads. Engineering, production and economic advantages obtainable with closed die forgings are presented in this reference book on forgings. Write for copy today or attach coupon to your business letterhead.

A New Movie entitled, "Forging in Closed Dies," reveals all aspects of the closed die forging process of forming parts. Represents over ten years of planning and research. It is available for industrial training, sales training, instruction in engineering and metallurgy courses at the college level, and for technical, industrial and engineering societies. Write for information about loan of film without cost.



DROP FORGING ASSOCIATION

605 Hanna Building

CLEVELAND 15, OHIO

DROP FORGING ASSOCIATION
605 Hanna Bldg., Cleveland 15, Ohio

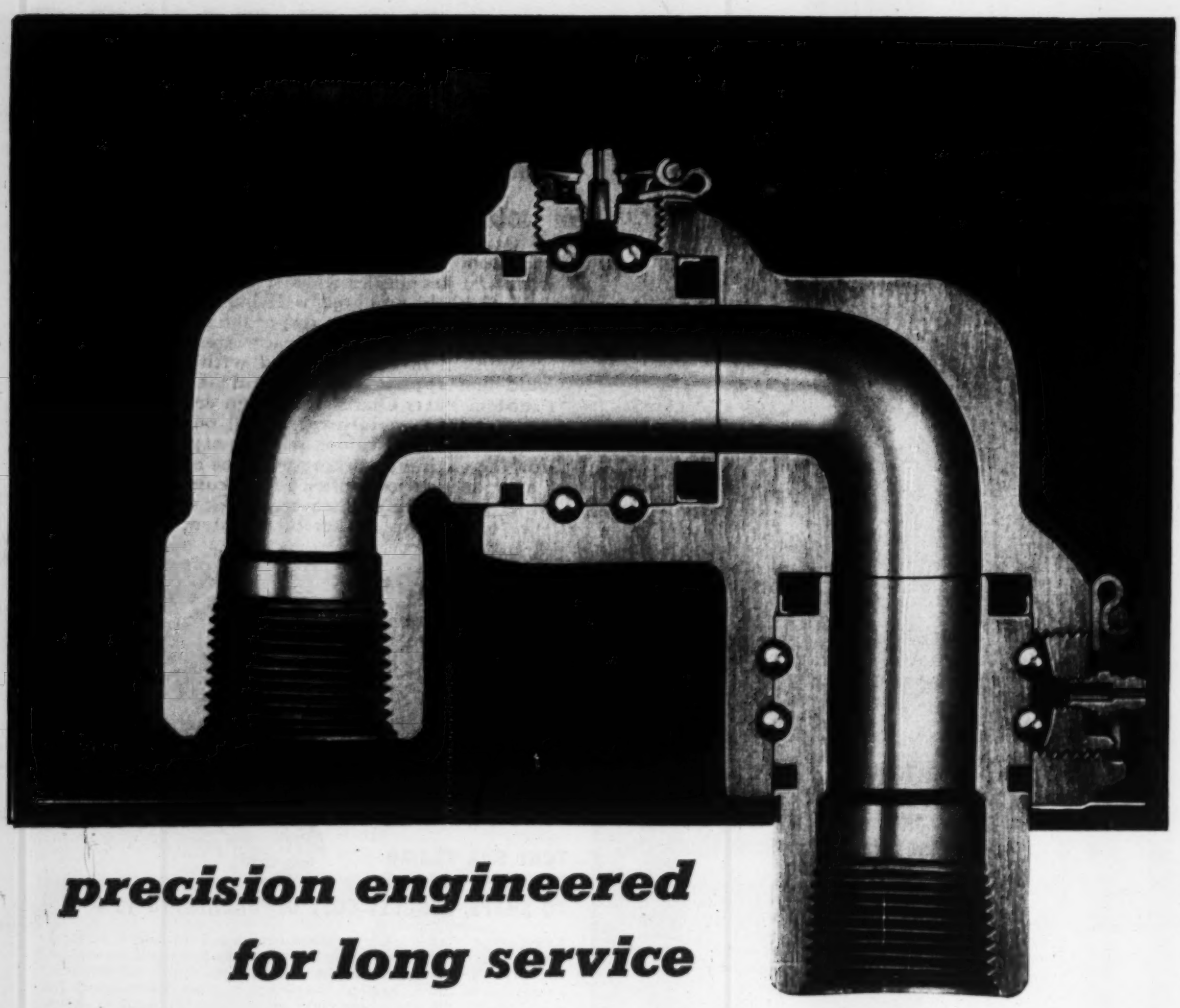
Please send 64-page booklet entitled, "Metal Quality" —How Hot Working Improves Properties of Metal," 1953 Edition.

Name .....

Position .....

Company .....

Address .....



precision engineered for long service

CHIKSAN Ball-Bearing Swivel Joints are precision engineered like a fine watch to give unlimited flexibility and unlimited service in the conduct of fluids, gases and liquids.

CHIKSAN is the originator and largest exclusive manufacturer of ball-bearing swivel joints in the world today.

CHIKSAN produces packing designs for specific service requirements, assuring constant torque at any given pressure.

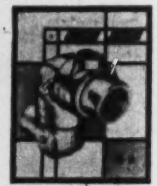
CHIKSAN has acquired a world-wide recognition for highest quality of product and lowest maintenance costs.

CHIKSAN has over a quarter of a century of "know-how" in the design, manufacture and successful scientific application of ball-bearing swivel joints in industry.

CHIKSAN offers the widest range of styles, sizes and pressures available for every major industrial use today.

CHIKSAN has complete nation-wide coverage of its products and applications by qualified field service engineers.

CHIKSAN will custom engineer for you the solution to any problems involving the transport of fluids, gases and liquids.



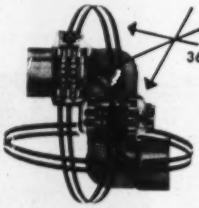
Write CHIKSAN for latest INDUSTRIAL CATALOG—G-4 Dept. 12-ME

Supply and Service of CHIKSAN Ball-Bearing Swivel Joints is always as near as your telephone.

The Flow of Enterprise Relies on

CHIKSAN

Ball-Bearing Swivel Joints

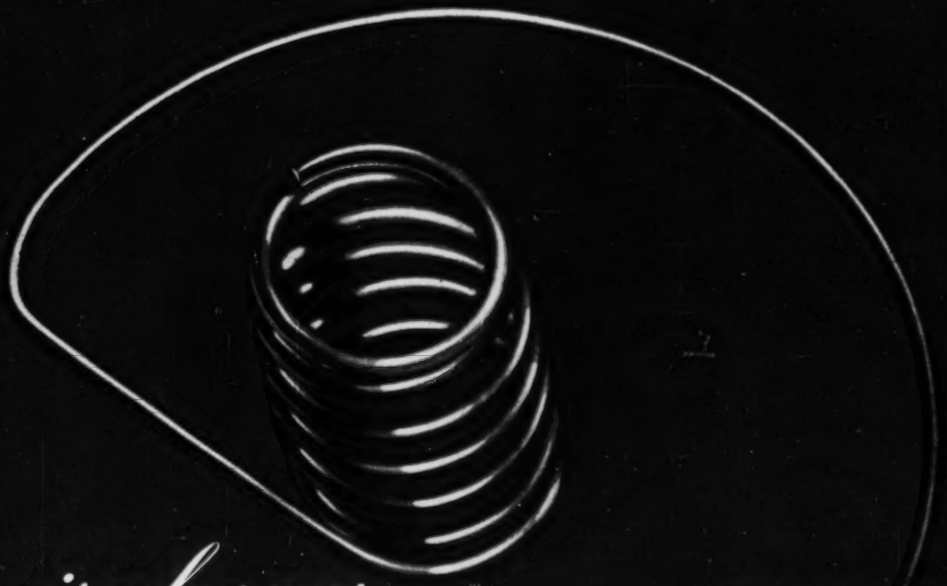


CHIKSAN Ball Bearing Swivel Joints are THE NEW TOOL of Modern Industry with full 360° rotation in 1, 2, and 3 planes. Over 1,000 different types, styles, and sizes have been developed for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 70° to a plus 500° F. with packing materials for each specific service.

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 3, Illinois • Newark 2, New Jersey

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co., Brea, Calif.; Newark 2, N. J. • Chiksan of Canada Ltd., Edmonton, Alta.

a SPRING



is always

IMPORTANT

Divisions of ASSOCIATED SPRING CORPORATION

WALLACE BARNES COMPANY
BRISTOL, CONNECTICUT

THE WILLIAM D. GIBSON COMPANY
1800 CLYBOURN AVE. CHICAGO 14,

RAYMOND Manufacturing COMPANY
CORRY, PENNSYLVANIA

BARNES-GIBSON-RAYMOND
40300 PLYMOUTH RD. PLYMOUTH, MICH.

B·G·R COOK PLANT
ANN ARBOR MICHIGAN

10 PROVEN SOURCES COAST TO COAST

F. N. MANROSS AND SONS CO.
BRISTOL CONNECTICUT

OHIO DIVISION
1825 EAST FIRST ST. DAYTON, OHIO

DUNBAR BROTHERS COMPANY
BRISTOL, CONN.

MILWAUKEE DIVISION
341 E. ERIE ST. MILWAUKEE, WIS

SEABOARD Coil Spring Div.
15001 S. BROADWAY GARDENA, CALIF.

COPYRIGHT 1952 WALLACE BARNES CO., LTD. HAMILTON, ONTARIO

SEE OVER

SEE A DIVISION OF

ASSOCIATED SPRING CORPORATION

WALLACE BARNES COMPANY
BRISTOL, CONNECTICUT

THE WILLIAM D. GIBSON COMPANY
1800 CLYBOURN AVE. CHICAGO 14,

RAYMOND Manufacturing COMPANY
CORRY, PENNSYLVANIA

BARNES-GIBSON-RAYMOND
40300 PLYMOUTH RD. PLYMOUTH, MICH.

B-G-R COOK PLANT
ANN ARBOR MICHIGAN

F. N. MANROSS AND SONS CO.
BRISTOL CONNECTICUT

OHIO DIVISION
1825 EAST FIRST ST. DAYTON, OHIO

DUNBAR BROTHERS COMPANY
BRISTOL, CONN.

MILWAUKEE DIVISION
341 E. ERIE ST. MILWAUKEE, WIS.

SEABOARD Coil Spring Div.
15001 S. BROADWAY GARDENA, CALIF.

IN CANADA
The Wallace Barnes Co. Ltd
Hamilton, Ontario

IF your present conveyors aren't doing a PERFECT job—

INVESTIGATE this amazing NEW CONVEYOR!

IF your product is too hot, sharp or oily for belt or flight conveying, or too abrasive or sticky for screw or apron conveying — if you're getting excessive spillage, if you have cleaning problems, or any other conveying difficulties — *you owe it to yourself to investigate the Carrier Natural-Frequency Conveyor.*

These revolutionary conveyors are an entirely new *type* of vibrating equipment which substitutes Natural-Frequency spring action for brute force. Where "brute-force" conveyors may use up to 90% of their power to operate their moving parts and only about 10% to convey their loads, *the Natural-Frequency Conveyor uses substantially no more power to operate, empty, than is required to run the motor alone.*

CARRIER ADVANTAGES

HIGH CONVEYING SPEED
(Up to 100 feet per minute)

GREATER CAPACITY
(Up to 200 tons per hour)

LESS POWER REQUIRED
(About one-third as much as "competitive" equipment)

LESS MAINTENANCE & DOWN-TIME
(Less power + good design = trouble-free performance)

NO DAMPENING UNDER LOAD
(Designed with extra power for specified load, with positive stroke)

SELF-CLEANING
(Continuous, smooth trough — no pockets)

COMBINES PROCESSING WITH CONVEYING
(Can screen, dry, cool, dewater, blend, etc.)

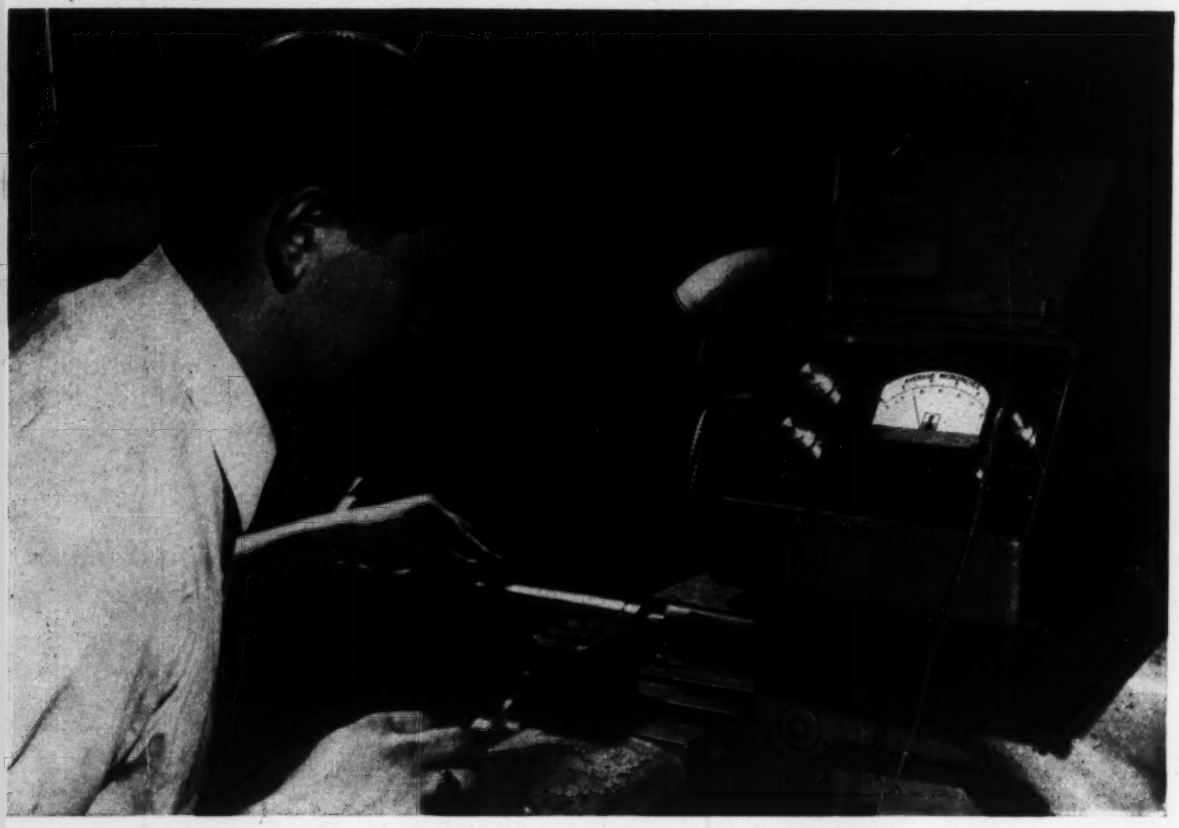
WIDTHS FROM 6" TO 48"—LENGTHS FROM 5' TO 250'
(With pans 16 ga to ½" plate, of any metal, open or enclosed)

BALANCED, VIBRATION-FREE UNITS AVAILABLE
(For use on ceilings or light floor construction)

CARRIER ~~NATURAL-FREQUENCY~~ CONVEYORS

Carrier Conveyor Corporation
2134 Frankfort Avenue, Louisville 6, Kentucky
Gentlemen:
Without obligation, please send me Carrier Natural-Frequency Conveyor Bulletin No. 111

Firm_____
Street_____
City_____ State_____
Att. Mr._____ Dept._____



BRUSH SURFINDICATOR used to measure surface roughness of a titanium bar in a test lathe, at Metcut Research Associates. The company uses the instrument in evaluation of cutting tools and fluids, and determination of machining characteristics of various metals.

"SURFINDICATOR*—Indispensable in studying machining characteristics!"

"We have found the Brush SURFINDICATOR* indispensable in our research and development programs on machineability. The evaluation of cutting tools and materials requires accurate measurements of surface finish, for which the SURFINDICATOR is a most useful tool. It can be set up quickly, it is simple to use and its small head permits measuring a wide variety of metal parts."

—Metcut Research Associates, Cincinnati, Ohio

TRY IT YOURSELF! The Brush SURFINDICATOR makes the measurement of surface roughness a quick and easy operation. It can be set up anywhere in the plant where 115 volts a.c. is available. Write for a copy of this booklet describing surface finish control—or ask for a demonstration of the SURFINDICATOR in your plant. Send coupon now. Brush representatives are located throughout the U.S. In Canada: A. C. Wickman, Ltd., Toronto. Brush Electronics Co., Cleveland 14, Ohio.

*Trade-Mark

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT

formerly
The Brush Development Co.
Brush Electronics Company
is an operating unit of
Clevite Corporation.

BRUSH ELECTRONICS COMPANY, Dept. P-12
3405 Perkins Avenue, Cleveland 14, Ohio

☐ Please send free copy of "Surface Finish Control".
☐ Have your nearest representative demonstrate the SURFINDICATOR to me.

Name _____

Position _____

Company _____

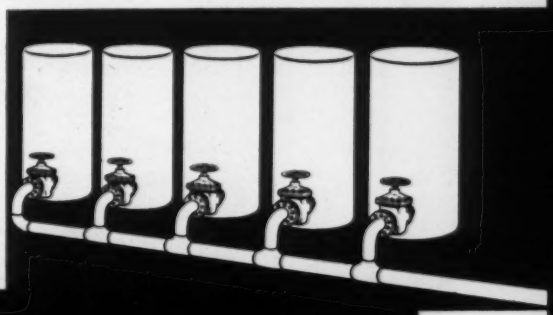
Address _____

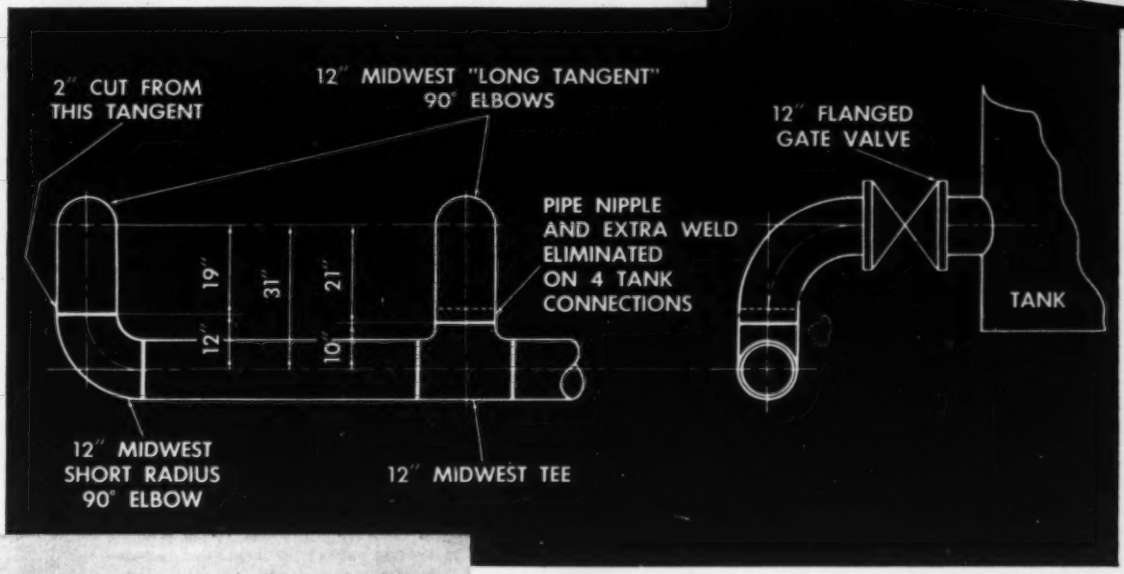
City _____ *State* _____

MIDWEST "LONG TANGENT" ELBOWS

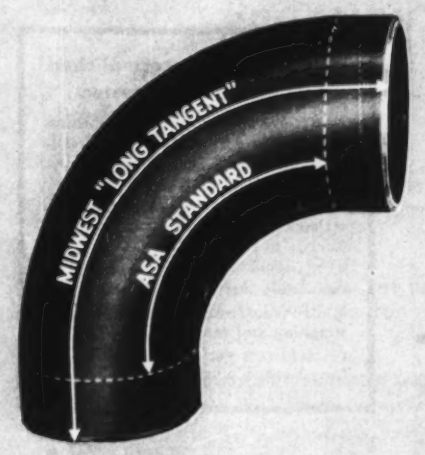
SAVED $156.20

On This Welding Piping





MIDWEST "LONG TANGENT" ELBOWS COST NO MORE THAN OTHER ELBOWS



The Problem:

To connect the five tanks shown in the sketch at top to a common 12" header.

The Difficulty:

The center-to-outlet dimension of the 4—12" tees is only 10", while the shortest elbow available measures 12" center-to-end, Thus, if standard long radius elbows are used next to the five tank valves, four short nipples and four extra 12" welds would be required.

The Solution:

By using Midwest "Long Tangent" elbows as shown in the blueprint, the expense of the four extra nipples and welds was eliminated at the cost of just one cut! The actual net savings made by "Long Tangent" elbows on this job was $156.20.

Remember—Midwest "Long Tangent" elbows cost no more than regular elbows! For further information, write for Catalog 54.

MIDWEST PIPING COMPANY, INC.

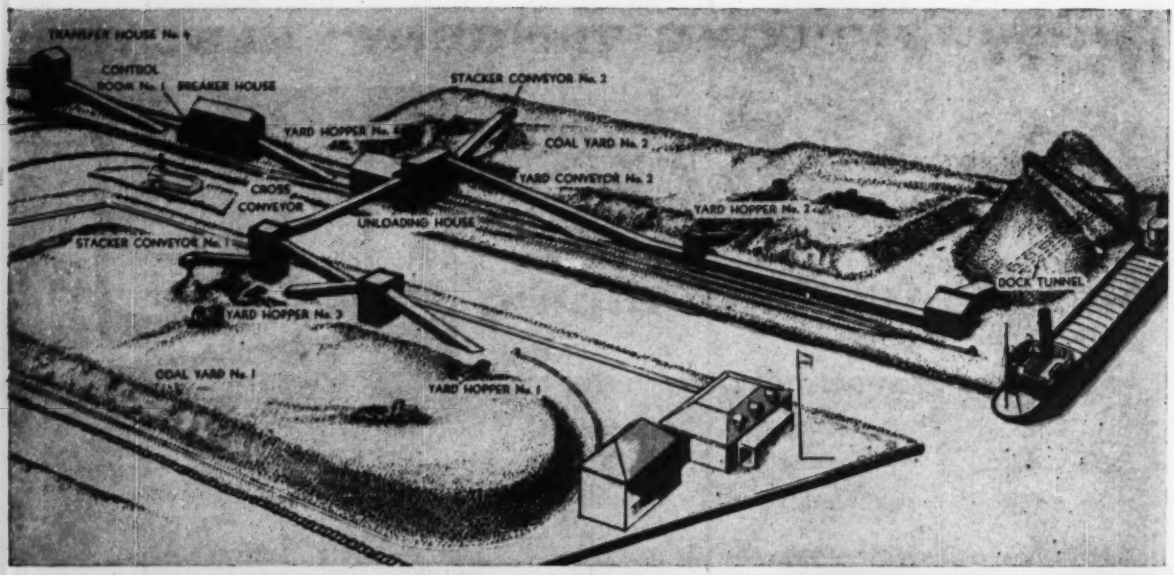
Main Office, 1450 South Second St., St. Louis 4, Missouri

PLANTS: ST. LOUIS, PASSAIC, LOS ANGELES, and BOSTON

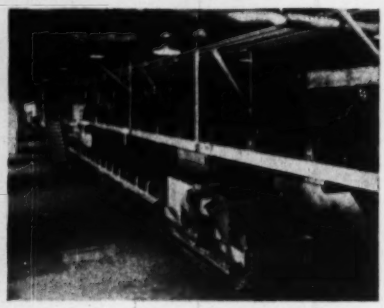
SALES OFFICES: NEW YORK 7—50 CHURCH ST. • LOS ANGELES 33—520 ANDERSON ST.
BOSTON 27—426 FIRST ST. • CHICAGO 3—79 WEST MONROE ST.
CLEVELAND 14—616 ST. CLAIR AVE. • HOUSTON 2—1213 CAPITOL AVE.
TULSA 3—224 WRIGHT BLDG.

6820

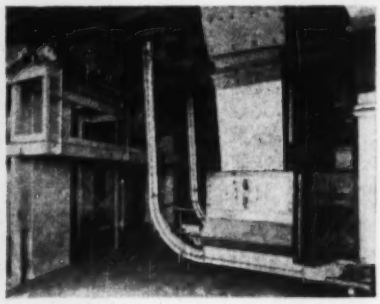
MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS



Under coal dock, Link-Belt reclaim conveyor is fed by eight belt feeders.



Belt conveyor delivers to reversible shuttle feeder over low-pressure plant bunkers.



Two Bulk-Flo conveyor-elevators deliver coal to crushers for continuous sampling.

Link-Belt system directs 2000 tons of coal an hour with

push-button conveyor automation

ONE reason America's power companies can provide homes and businesses with low-cost electricity is the efficiency with which they handle coal. The case of Detroit-Edison's addition to their Conners Creek station illustrates the automation possible.

Working with Link-Belt engineers, Detroit-Edison solved a complex coal handling problem. Today one man at a central control board can select any one of eleven sequences to move coal from boat to stock at up to 2000 tons per hour, or railroad car to bunkers at up to 800 tons per hour. The result: Handling costs are *among the industry's lowest.*

This is an example of the results achieved by Link-Belt. Here is a single source for the planning, manufacture and erection of materials handling systems large and small. Whether you're moving coal or cookies . . . steel or sawdust—it will pay you to call the Link-Belt office near you. For detailed information on modern power plant layouts, write for Book 2410. LINK-BELT COMPANY, Dept. AV, 307 N. Michigan Ave., Chicago 1, Ill.

13,869

LINK-BELT

Here's what is accomplished with this Link-Belt system:

1. Receive approximately 1.3 million tons of coal a year by boat and rail.
2. Handle and keep separate two different kinds of coal.
3. Store coal in two separate yards, reclaim coal from these yards or feed directly to power plants.
4. Maintain centralized control of electrically interlocked system.
5. Provide continuous, automatic weighing and sampling.
6. Hold cost per ton handled to the lowest possible figure.

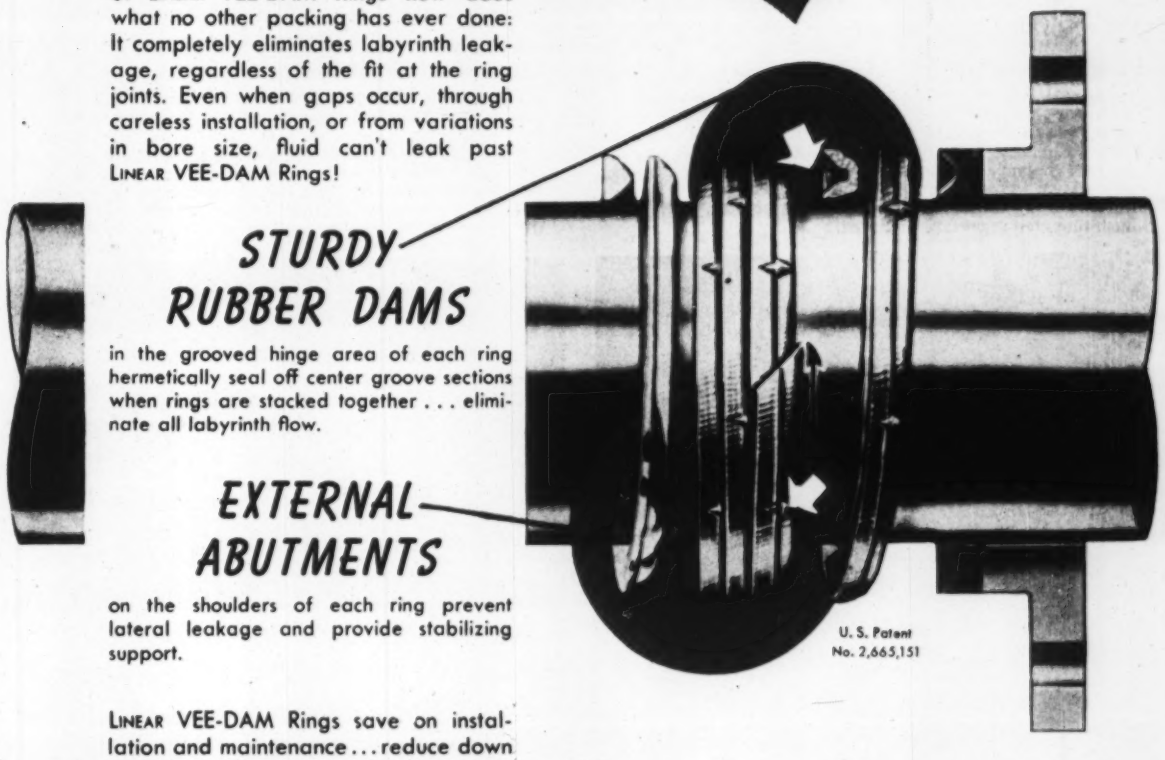
One source . . . one responsibility

for materials handling — power transmission — processing machinery

NEWS

LINEAR VEE-DAM RINGS

Unique, new and revolutionary design of LINEAR VEE-DAM Rings now does what no other packing has ever done: It completely eliminates labyrinth leakage, regardless of the fit at the ring joints. Even when gaps occur, through careless installation, or from variations in bore size, fluid can't leak past LINEAR VEE-DAM Rings!



U. S. Patent No. 2,665,151

STURDY RUBBER DAMS

in the grooved hinge area of each ring hermetically seal off center groove sections when rings are stacked together . . . eliminate all labyrinth flow.

EXTERNAL ABUTMENTS

on the shoulders of each ring prevent lateral leakage and provide stabilizing support.

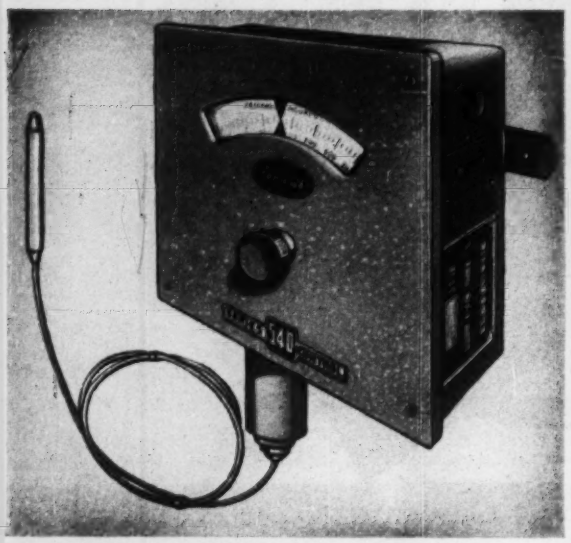
LINEAR VEE-DAM Rings save on installation and maintenance . . . reduce down time. They last longer, work better! We're molding them in a variety of sizes and compounds. Let us show you how VEE-DAM Rings can solve your packing problems!

"PERFECTLY ENGINEERED PACKINGS"

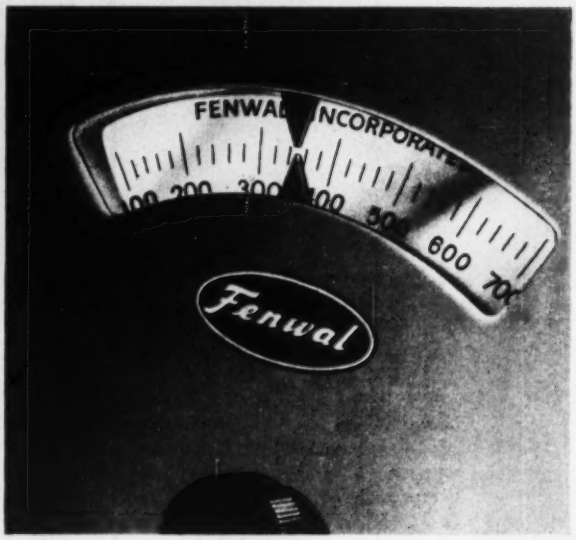
LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

Now . . . a new Temperature Indicator-Controller by Fenwal



1. FENWAL'S NEW SERIES 540 is a remote Temperature Indicator-Controller that combines low cost with high accuracy over a temperature range of 100° to 700°F. Designed for ovens, packaging and processing equipment of all types, the new controller operates on a liquid-filled bulb and capillary system whose response to temperature changes is transmitted through a bellows to an indicating pointer. It may be flush-mounted or surface-mounted.

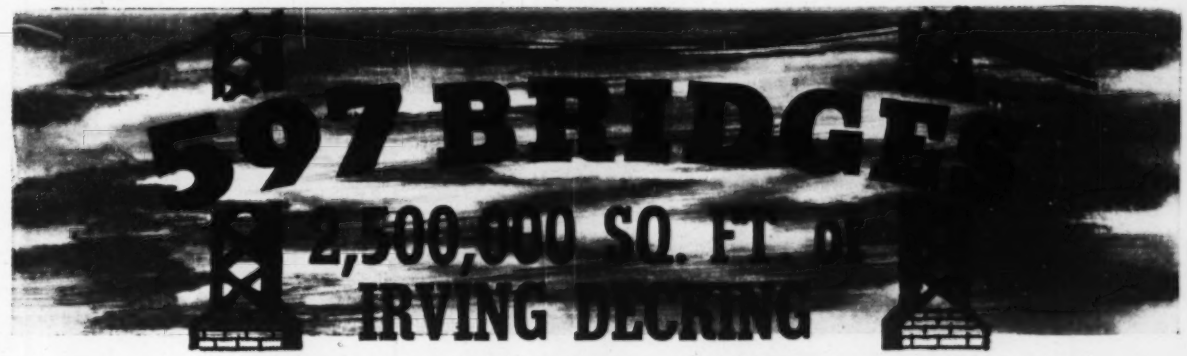


2. "SET" AND "CHECK" ARE EASY. Temperature setting pointer and bulb temperature pointer pivot on the same axis, indicating against the same scale face. This permits "glance" comparison of actual and set-point readings at considerable distance from the dial. An adjustable differential, variable between 0.8% and 4% of scale range, permits adjusting the operating bandwidth to balance closeness of control against slower cycling and longer equipment life.

3. ACCURACY IS ASSURED. Temperature indication is accurate to within 3% over the 100° to 700°F range, including the effects of ambient temperature in the range of 50° to 150°F. Accuracy increases for narrower ranges. Uniform control and accurate calibration are maintained with typical Fenwal precision in this new, popular-priced addition to a famous line of temperature control and detection devices.

4. SEND FOR NEW BULLETIN. Get all the facts on how closely the new Series 540 meets your requirements for an economical, accurate indicator-controller. Write for comprehensive bulletin MC122. And remember, we're always ready to help in any problems concerning temperature control and detection. **Fenwal Incorporated, 512 Pleasant Street, Ashland, Mass.**

Fenwal Controls Temperatures . . . *Precisely*



Emphasize the Engineering Advantages of Irving Bridge Decking.

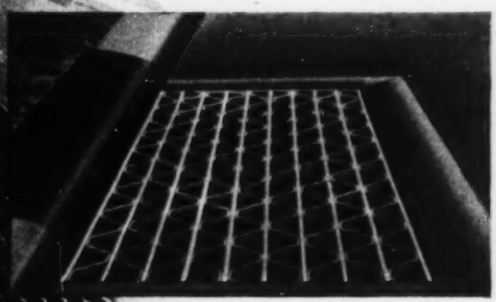
IRVING DECKING is 80% open, self-cleaning and self-draining, non-floating, not affected by wind pressure, lightweight, strong, safe, practically self-maintaining.

ONLY IRVING OFFERS you over 50 years of experience in quality production and sound application of open mesh metal flooring. Take advantage of it! Write for new engineering data catalog covering all fields of application.

"A FITTING GRATING FOR EVERY PURPOSE"

Manufacturers of Riveted, Pressure-Locked, and Welded Gratings.

Sidewalk Grating for Bridges, Gutter Catch Basin Covers, Armourings for Heavy Duty Floors, Trucking Aisles, Loading Platforms, Boiler Room and Plant Flooring, Catwalks, Runways, Stair Treads, Sidewalk Grating, Tree Guards, Balcony Flooring, Airfield Landing Mats.



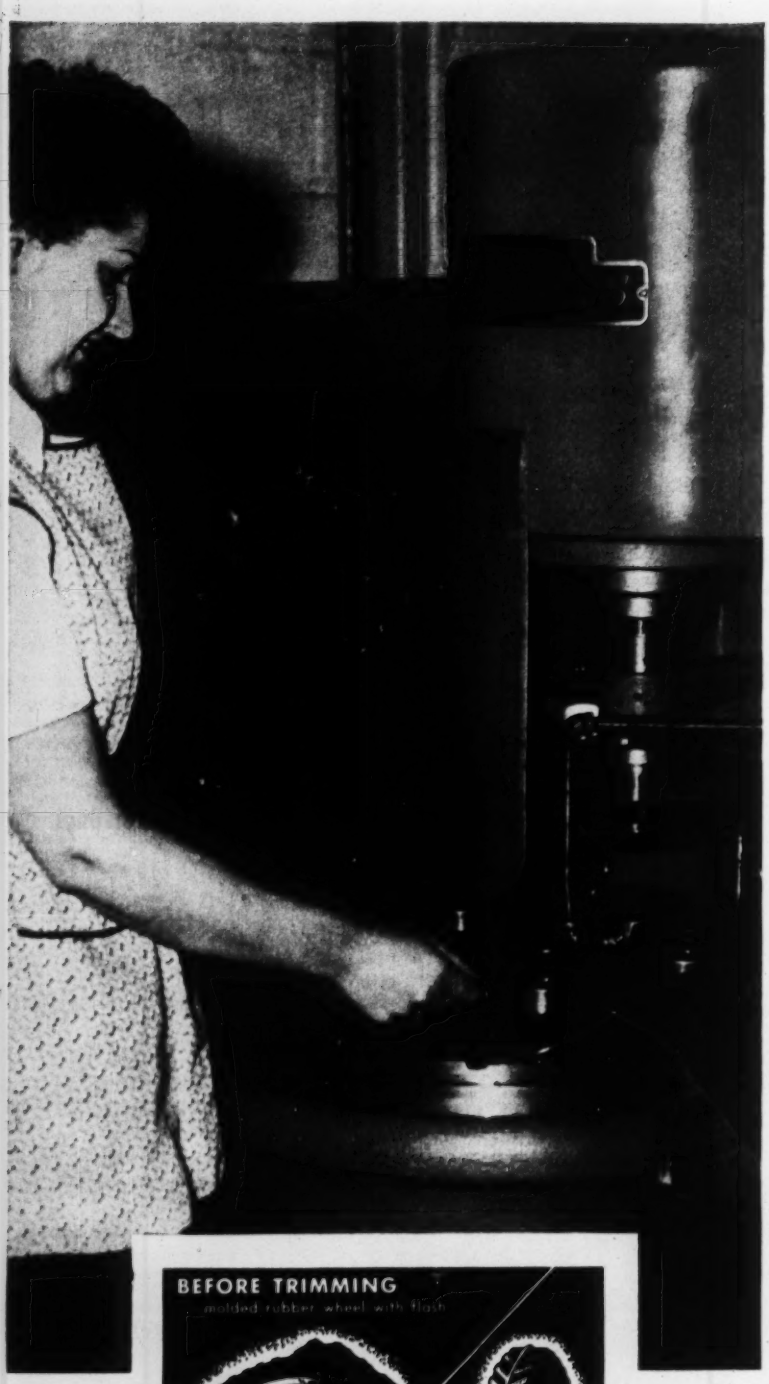
IRVING "DRYWAY" DRAINGRATES are simple to install, easy and inexpensive to maintain. These safe, clean and strong drain covers are available in Rectangular Mesh and Riveted Types.

IRVING SUBWAY GRATING CO. INC.

ESTABLISHED 1902

OFFICES and PLANTS at

[illegible] 27th ST., LONG ISLAND CITY 1, N. Y. • 1810 10th ST., OAKLAND 20, CALIFORNIA



Eliminates 3 costly operations with DENISON® MULTIPRESS

Three time-consuming operations eliminated.

Production doubled.

A better product at less cost.

. . . all because of a switch to Denison hydraulic Multipress.

At The Nye Rubber Company, Barberton, Ohio, the old method for trimming flash from molded rubber wheels required cutting, freezing, tumbling, buffing and washing—with parts loaded and unloaded by hand for each operation. Now, a 4-ton Multipress trims flash automatically.

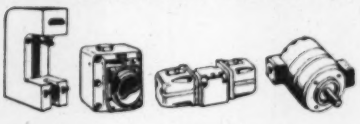
The operator simply loads parts, which are carried under the ram by a Denison Index Table. One smooth hydraulic stroke trims the flash neat and close. Air blows the finished product down a chute for packing. The rate for one operator: 2400 parts an hour.

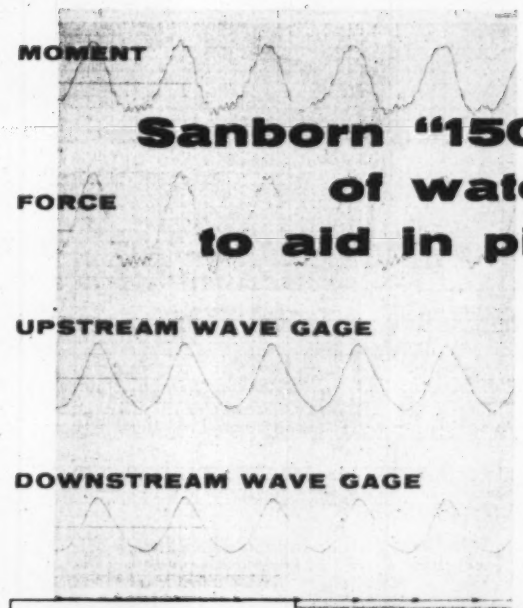
A switch to Denison Multipress could cut costly operations in your plant. Write for cost-cutting ideas and technical bulletins.

THE DENISON ENGINEERING COMPANY
1174 Dublin Road • Columbus 16, Ohio

DENISON Hydr OIL ics

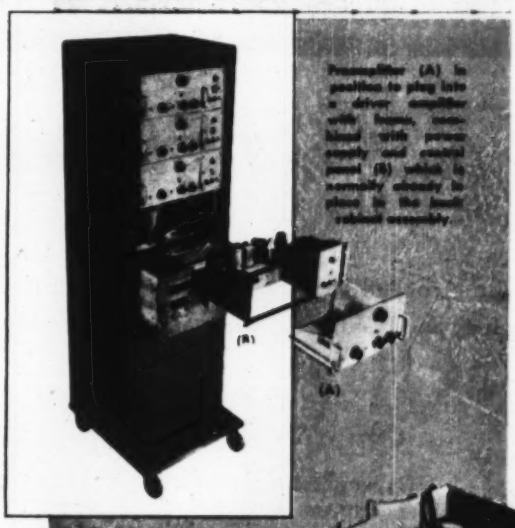
HYDRAULIC PRESSES
PUMPS • MOTORS • CONTROLS





Sanborn "150" records the effects of water wave forces to aid in pile structure design

By means of a Sanborn 150 Oscillographic Recording System equipped with four carrier type preamplifiers, engineers at the M.I.T. Hydrodynamics Laboratory are getting accurate pictures of simulated shallow water waves and their effect on dummy piles. The shape and length of precisely controlled waves in a 90 foot glass flume are plotted simultaneously with their moment and force on a suspended cylindrical pile. The excellent frequency response available with this method permits a sensitivity and accuracy not obtainable in previous model studies of this type.



Preamplifier (A) in position to plug into a driver amplifier with frame, combined with power supply and control panel (B) which is normally already in place in the basic cabinet assembly.

This is but one of MANY applications possible with Sanborn 150 Oscillographic Recording Systems

Virtually all electrical phenomena, within a frequency range of zero to 100 cps, can be accurately, permanently and graphically registered by Sanborn Oscillographic Recording Systems. This versatility of application is possible because of the *flexibility* of Sanborn 150 Series Recording Systems. A wide variety of quickly *interchangeable* preamplifiers, which plug in to *built-in* driver amplifiers (illustrated at left), are available for use with Series 150 Systems, to record such phenomena as: stress, strain, pressure, displacement, thickness, velocity, acceleration, current, voltage, temperature, torque, light, flow, force, load, position, rpm, radiation, tension, and power.

Add to this versatility the Sanborn features of inkless tracings in true rectangular coordinates, on plastic coated chart paper . . . high torque movement . . . time and code markers . . . numerous chart speeds.

Let Sanborn Answer YOUR Recording Requirements

For informative technical data on the basic 1, 2, and 4 channel Sanborn systems, and qualified counsel to help you select the correct Sanborn equipment for your requirements, write to

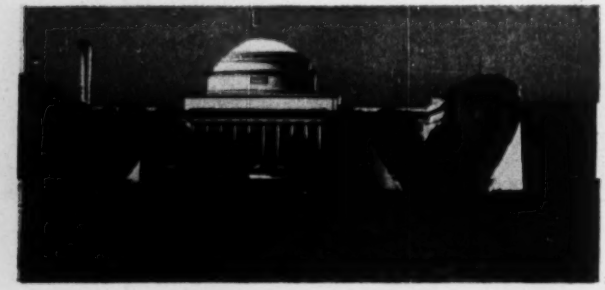
SANBORN COMPANY

INDUSTRIAL DIVISION
CAMBRIDGE 39, MASSACHUSETTS

Another M. I. T. *Building Equipped*

In this Famous Scientific Institute Powers thermostatic control for heating and air conditioning systems is used in the new Dorrance Laboratory for Biology and Food Technology and in the buildings listed below.

- **MAIN EDUCATIONAL AND ADMINISTRATION BUILDINGS**
- **GAS TURBINE LABORATORY**
- **CHEMICAL ENGINEERING BUILDING**
  Architects: Coolidge and Carlson • Contractor: The Downey Co.
- **HAYDEN MEMORIAL LIBRARY**
  Architects and Engineers: Vorhees, Walker, Foley and Smith
  Contractor: Cleghorn Co.
- **NUCLEAR SCIENCE LABORATORY**
  Architects: Anderson & Beckwith • Contractor: The Merrill Co., Inc.
- **SWIMMING POOL BUILDING**
  Architects: Anderson & Beckwith
  Engineers: Wolff & Munier • Contractor: H. E. Whitten Co.
- **NEW AUDITORIUM, now under construction**
  Architects: Eero Saarinen & Associates
  Associate Architects: Anderson & Beckwith
  Engineer: Hyde & Bobbio • Contractor: H. E. Whitten Co.



Other Prominent Users of

UNITED STATES CAPITOL
House and Senate Chambers
UNITED NATIONS
General Assembly
and Conference Buildings
HARVARD UNIVERSITY
Various Prominent Buildings

POWERS CONTROL

Argonne National Laboratory • Abbott Laboratories
Aluminum Co. of America • American Telephone & Tel. Co.
American Optical Co. • Anheuser Busch Co. • Armour & Co.
Bendix Aviation Corp. • Bachman-Uxbridge Worsted Co.
• Celanese Corp. of America
Chrysler Corp. • Ford Motor Co. • General Motors Corp.
Douglas Aircraft Co. • E. I. DuPont de Nemours Co.
Esso Research Center • Eastman Kodak Co.
B. F. Goodrich Tire & Rubber Co. • Humble Oil Co.
Johns Manville Co. • Johnson & Johnson Co.
Lever Brothers Co. • Eli Lilly & Co. • Lily Tulip Cup Corp.
Lahey Clinic • Massachusetts General Hospital
Massachusetts Mutual Life Insurance Co.
Monsanto Chemical Co. • Montgomery Ward & Co.
Parke Davis & Co. • Pepperell Mfg. Co. • Sears Roebuck & Co.
Sharp & Dohme Inc. • Swift & Co. • Thompson Products, Inc.
Wm. Wrigley Co. • Hiram Walker Inc. • Wyman-Gordon Co.
New York Stock Exchange • Radio City Music Hall
Madison Square and Boston Garden • Rockefeller Center

JOHN THOMPSON DORRANCE LABORATORY

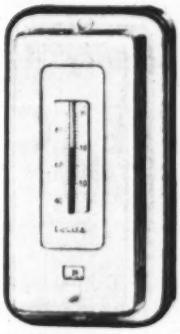
FOR
BIOLOGY and FOOD
TECHNOLOGY

Architects
ANDERSON & BECKWITH

Engineers
CLEVERDON, VARNEY & PIKE

Contractor
JAS. S. CASSEDY, INC.

with a POWERS Pneumatic System of *Temperature Control*



Powers Room Type Thermostat pneumatically regulates heating and air conditioning systems. Outstanding for accuracy and dependability.

Laboratory with an Exciting Future — From this modern laboratory with its excellent staff and research facilities will come great advances that will surpass the progress of the past and produce discoveries which will benefit us all.

Correct room temperature and humidity is important here. Research labs, animal rooms, constant temperature rooms and classrooms require the even, constant temperature assured by a Powers control system.

When you want dependable, accurate control for heating, cooling or air conditioning for any building or industrial process call Powers. With over 60 years of experience and efficient modern equipment we can help you select the best control for your requirements.

THE POWERS REGULATOR CO.

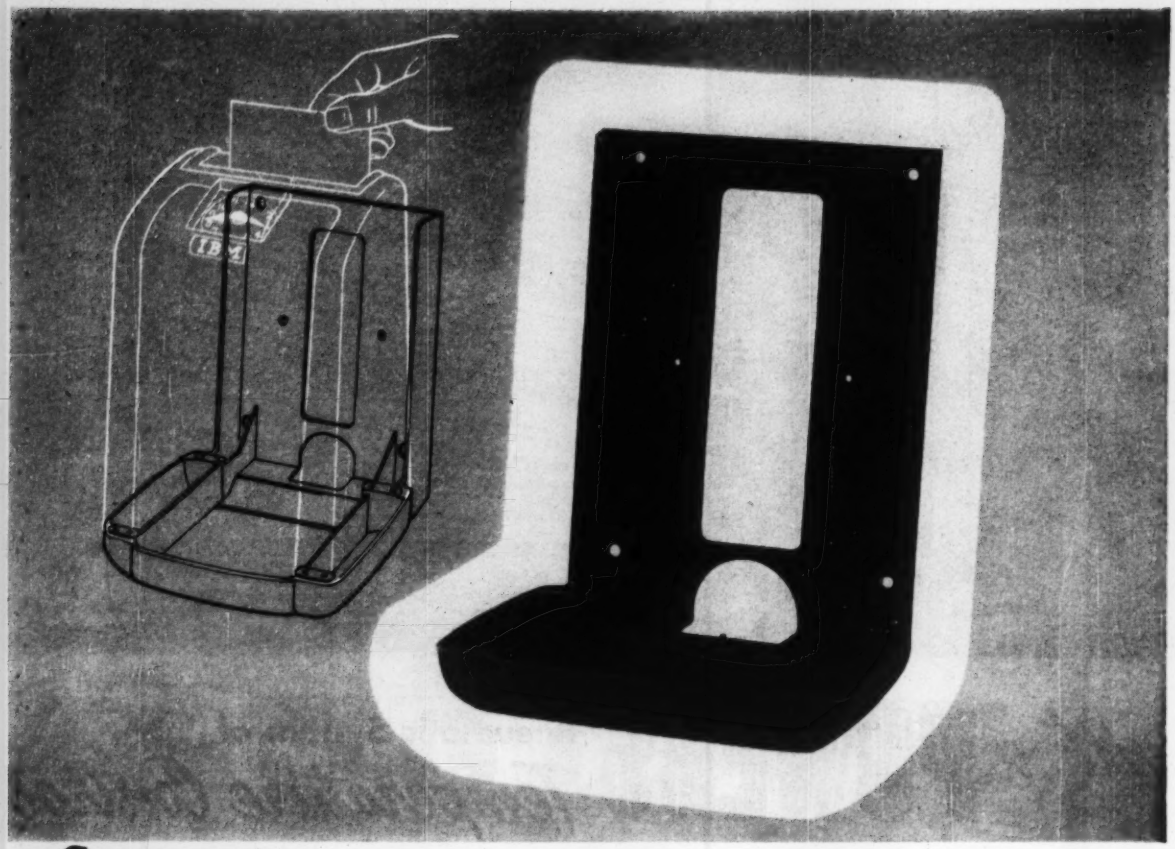
OVER 60 YEARS OF AUTOMATIC TEMPERATURE CONTROL

SKOKIE, ILLINOIS • Offices in Over 50 Cities in U. S. A., CANADA and MEXICO

(b46)

POWERS **PACKLESS** VALVES

. . . eliminate packing maintenance, leakage of water or steam, or loss of vacuum.



TIME MARCHES ON *automatically . . . supported by*

PARKER DIE CASTINGS

PARKER
SALES ENGINEERS

CHICAGO 49, Ill.
Ollie J. Berger Company • 2059 East 72 Street

CINCINNATI, Ohio
William H. Broxterman • 2174 Buck Street

DETROIT 35, Mich.
Hodgson-Geisler Co. • 18917 James Couzens

GIRARD, Penna.
Daniel F. Marsh • 35 Chestnut Street

WILTON, Conn.
Girard L. Palmer • Belden Hill Road

SYRACUSE, N. Y.
J. C. Palmer • 712 State Tower Bldg.

BELLEFONTE, Penna.
Warren G. Olson • 420 East Linn Street

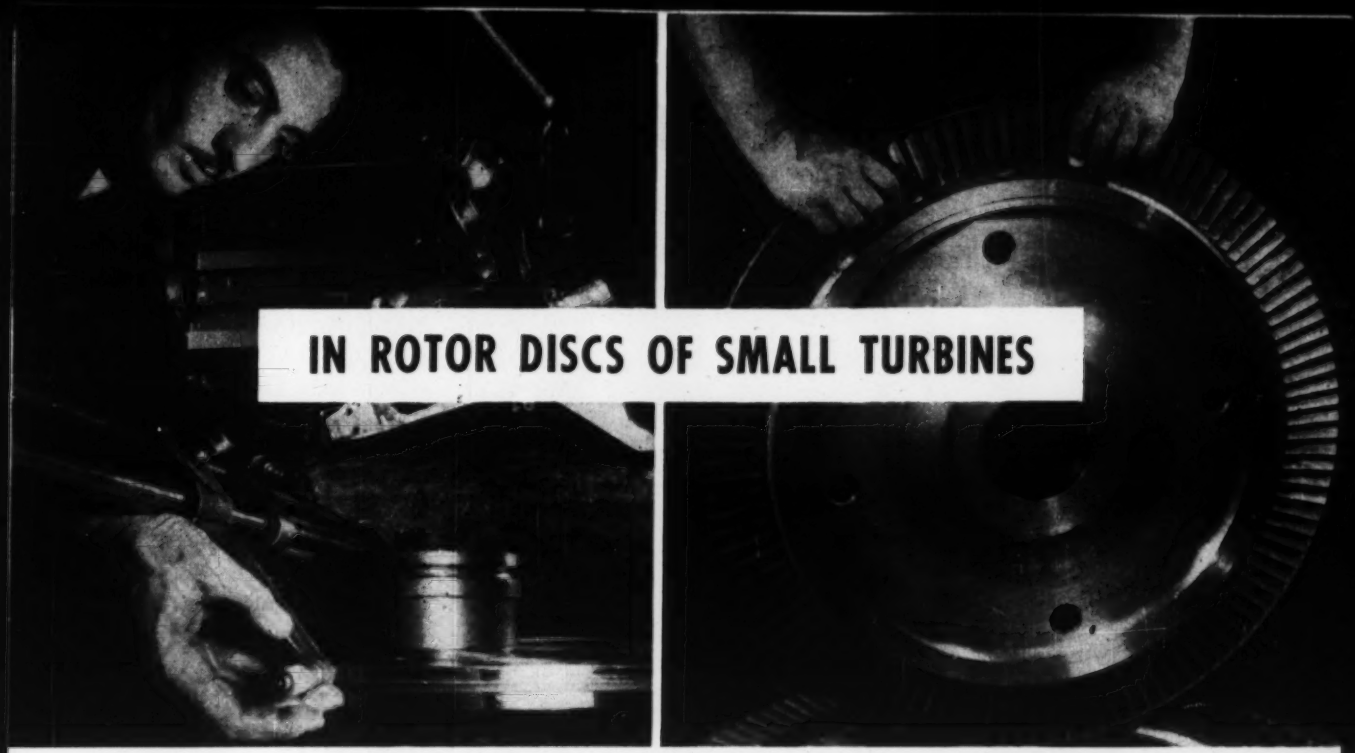
KIRKWOOD 22, Missouri
Edward F. Higgins, Jr. • 7 Orchard Way

IBM's fully-automatic, electric time recorder is a far cry from the old-fashioned time clock. This modern engineering development handles with ease and sureness any kind of work schedule, no matter how complex. To produce the wall mounting bracket shown above, IBM and Parker together worked out the design of the part. The result: a die casting that meets every specification at lower total cost.

This close co-operation from blue print to finished product typifies the complete engineering—as well as manufacturing—service offered by Parker. No matter how complex your die casting problem, Parker will be glad to help you find the answer. Just call the nearest Parker sales engineer listed at the left or write the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pa.

PARKER **ALUMINUM and ZINC *die castings***



IN ROTOR DISCS OF SMALL TURBINES

MACHINING THE GROOVED SEAT along the rim of a T-1 turbine disc. Turbine blades are positioned in this groove. Elliott Company uses quenched, tempered, and stress relieved circles of T-1 steel in 1-1/16" to 3-1/2" thicknesses. Circles are contour machined; 1-1/4" steam balance holes are drilled in the web, and the shaft hole is bored and keyed. Grooved seat is then machined.

New USS Carilloy T-1 Steel cuts material cost 60%

Provides high strength at high temperature, and stability at high speed of rotation

• The Elliott Company, Jeannette, Pennsylvania, makes industrial steam turbines for driving pumps, fans, blowers, and other rotating equipment. The steel for the turbine discs must withstand high stresses at high temperatures and at speeds as high as 6,000 rpm. It must be sound throughout. That's why Elliott Company has switched to new USS Carilloy T-1 Steel in these discs.

T-1 provides a minimum yield strength of 90,000 psi. and good creep rupture strength to 900° F. It poses no severe fabrication problems. What's more, T-1 *costs 60% less* in this turbine application than the alloy steel previously used. And the switch to T-1 required *no change* in design.

Although USS Carilloy T-1 Steel is comparatively new, it already has proved well suited to a great variety of applications. In addition to great high-temperature strength, it has extraordinary toughness at temperatures *far below zero*. It has excellent resistance to impact abuse, impact abrasion, and atmospheric corrosion. By taking advantage of these superior properties, you can reduce the size and weight, increase the strength and durability, and reduce the cost of such varied equipment as pressure vessels, power shovels, draft lines, storage tanks, conveyors, bridges, and towers. Where field fabrication or repairs are necessary or desirable, T-1 cuts costs still further because it can be welded or flame cut *either in shop or field without pre-heating or stress relieving.*

Send the coupon for complete information.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

Carilloy USS Steels

ELECTRIC FURNACE OR OPEN HEARTH
COMPLETE PRODUCTION FACILITIES IN CHICAGO OR PITTSBURGH

4-2245

United States Steel, Room 4571
525 William Penn Place
Pittsburgh 30, Pa.

☐ Please send me your booklet "United States Steel presents T-1" which contains the full story of T-1 steel.

☐ Have your representative get in touch with me.

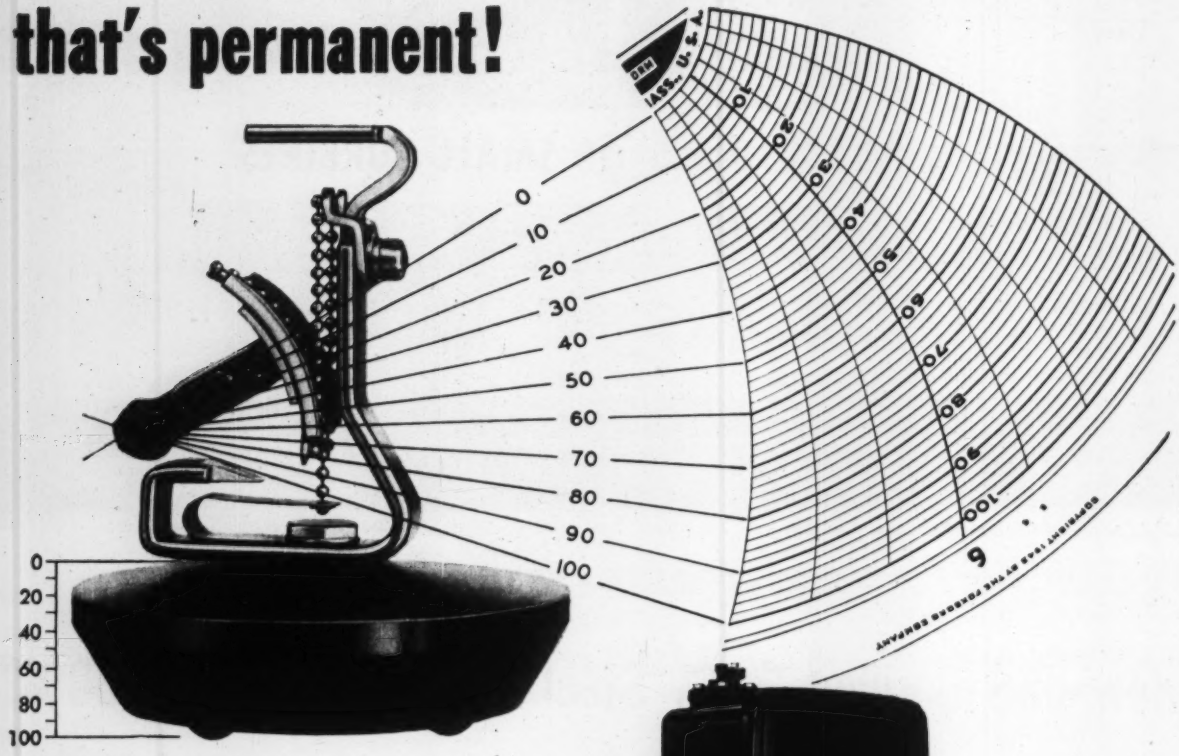
Name .....

Address .....

City ..... State .....

UNITED STATES STEEL

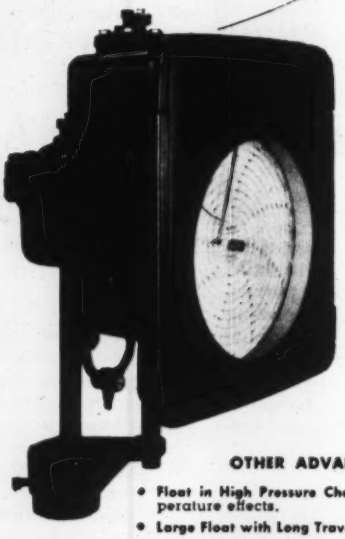
Full-scale meter accuracy that's permanent!



Exclusive Segmental Lever Design Gives Linear Transmission from Float to Pen Point . . . No Angularity Errors

A basic-design feature of Foxboro Flow Meters insures permanent calibration at all readings on the scale, by eliminating angularity errors and lost motion. The exclusive Segmental Lever drive transmits vertical motion of the float to the pen in positive, linear relationship. Its stainless steel ball chain runs free and true, regardless of meter alignment.

This is only one of several better-engineered features that have made Foxboro Flow Meters the unqualified choice of industries wherever dependability and "cash-register" accuracy of metering are important. Available in rectangular and circular case models. Write for complete story in Bulletin 460. **The Foxboro Company, 9612 Neponset Avenue, Foxboro, Massachusetts, U.S.A.**



OTHER ADVANCED FEATURES

- **Float in High Pressure Chamber** minimizes ambient temperature effects.
- **Large Float with Long Travel** gives high-power pen drive.
- **Sure-Seal Check Floats** with positive-seating ball plugs submerged in mercury prevent sticking, leaking, corrosion. Will not blow mercury.
- **Pressure Seal Bearing** is friction-free, completely leak-proof, interchangeable. No stuffing box. No lubricator.
- **Self-aligning, Union-Coupled U-Bend** — No gaskets. Fully-adjustable plug gives calibrated damping, directed drain.

OVER 100,000 FOXBORO FLOW METERS WITH SEGMENTAL LEVER ARE IN USE TODAY

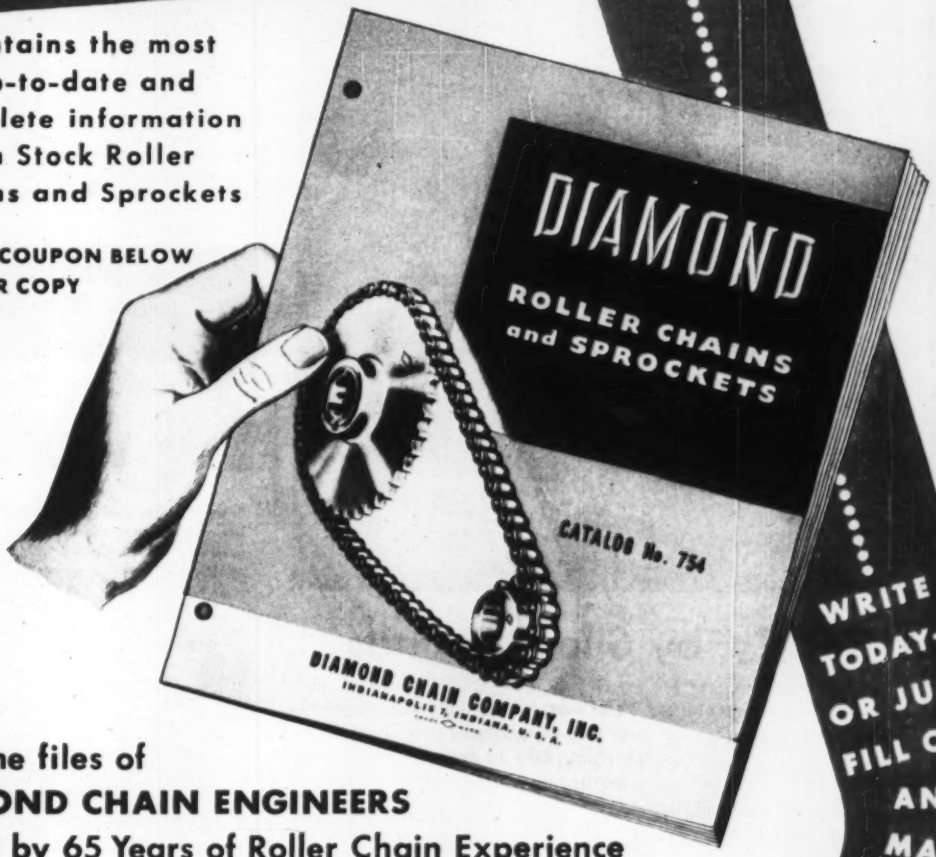
FOXBORO REG. U.S. PAT. OFF. — **First in FLOW METERS**

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

HERE'S YOUR LATEST COPY OF CATALOG 754 ... Just off the press!

Contains the most up-to-date and complete information on Stock Roller Chains and Sprockets

FILL OUT COUPON BELOW FOR YOUR COPY



WRITE TODAY— OR JUST FILL OUT AND MAIL THE COUPON

From the files of DIAMOND CHAIN ENGINEERS

Backed by 65 Years of Roller Chain Experience

In this latest 64-page Catalog 754, you will find the most authentic and complete data on Roller Chains and Sprockets—data drawn from 65 years of experience in the manufacture and application of Roller Chains. There is no substitute for such experience.

You will find it worth while to have a copy of Catalog 754 on your desk for ready reference. Write today—or just fill out and mail the coupon.

DIAMOND CHAIN COMPANY, Inc.

Dept. 413, 402 Kentucky Avenue, Indianapolis 7, Indiana

Offices and Distributors in All Principal Cities

Please refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER

DIAMOND **ROLLER CHAINS**

CLIP COUPON AND MAIL TODAY!

Diamond Chain Company, Inc.
Dept. 413, 402 Kentucky Ave.
Indianapolis 7, Ind.

Please mail a copy of your New Catalog 754 on Stock Chains and Sprockets to:

NAME _____

FIRM NAME _____

ADDRESS _____

CITY _____ ZONE ____ STATE _____

CAUGHT!—by Silent Sounds

Suddenly, the lights snap on. Someone yells—

"Don't move or we shoot!"

How had the burglar been detected? No one saw him enter. No sign of an alarm system.

No obvious sign, that is. But there *was* an Alertronic Burglar Alarm.

This unusual protective device operates by sending out 19,200 cycle-a-second sound waves, too high for human ears to hear. The slightest movement of an intruder disturbs these waves and activates the alarm.

What produces the vibrations? Two slender nickel rods—and a principle of physics called magnetostriction (the peculiar way nickel changes length in a changing magnetic field).

Putting magnetostriction to work in this ultrasonic burglar alarm wasn't an overnight job. The inventor made his first experiments twelve years ago.

The search for a material with necessary magnetostrictive properties ended when he came to Inco. Nickel proved to be the material he was seeking.

And, as it turned out, he got more than a metal from Inco . . .

In the years that have passed, he has found Inco always ready to help in supplying information on the properties of Inco Nickel Alloys and other metals . . . on the technical aspects of magnetostriction . . . and on questions involving metal fabrication.

This same type of friendly cooperation, of course, is yours for the asking. Let's get together on your problem.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

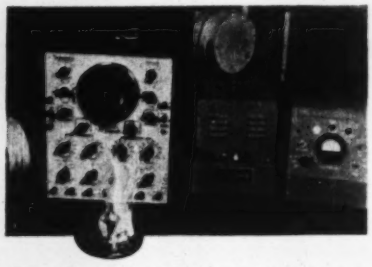
Inco Nickel Alloys

INCO TRADE MARK

NICKEL ITEMS

Who can guess what new use of magnetostriction will be announced next? Nickel transducers from little rods the size of match sticks up to ton-size blocks are already being used for killing germs by silent sounds, to measure ocean depths, to locate fish, for dust precipitation, for faster drilling of wells, for shaping gems and cutting tool materials so hard they normally have to be cut laboriously with diamonds.

When installed according to specifications of insurance underwriters and connected to central protective system, Alertronic enables users to qualify for 60% reduction in insurance premiums.



Even the motion of heated air from burning wad of paper in ash tray sets off Alertronic alarm as pictured by jumping lines of the oscillograph tube in this demonstration set-up.

Inventor Samuel Bagno, Vice President of The Ultrasonic Division of Walter Kidde & Co., Inc., flips a switch as he leaves his own plant to connect the alarm unit into Central Patrol Office.

If you really want more facts and technical data on the magnetostrictive properties of nickel, ask for our bulletin "Magnetostriction." It is written for engineers and physicists.

MONEL® • "R"® MONEL • "K"® MONEL "KR"® MONEL • "S"® MONEL • INCONEL® INCONEL "X"® • INCONEL "W"® INCOLOY® • NIMONIC® ALLOYS • NICKEL LOW CARBON NICKEL • DURANICKEL®

Volume 76 • Number 12

December 1954

•

Published by

The American Society of Mechanical Engineers

Editorial Department

GEORGE A. STETSON, *Editor*
K. W. CLENDINNING, *Managing Editor*
J. J. JAKLITSCH, JR., *Associate Editor*
E. S. NEWMAN, *News Editor*
J. FOSTER PETREE, *European Correspondent*

Advertising Department

S. A. TUCKER, *Publications Manager*
M. H. MARTY, *Business Manager*
N. M. LOSEFF, *Asst. Business Manager*

Officers of the ASME

LEWIS K. SILLCOX, *President*
J. L. KOPF, *Treasurer*
C. E. DAVIES, *Secretary*
E. J. KATES, *Assistant Treasurer*

Publications Committee

PAUL T. NORTON, JR., *Chairman*
OTTO DE LORENZI
COLIN CARMICHAEL
W. E. REASER
KERR ATKINSON
JOSEPH SCHMERLEI, PETER WALLACK — *Junior Advisory Members*

Regional Advisory Board

RICHARD L. ANTHONY—Region I
JOHN DE S. COUTINHO—Region II
WILLIAM N. RICHARDS—Region III
FRANCIS C. SMITH—Region IV
H. M. CATHER—Region V
J RUSSELL PARRISH—Region VI
J. KENNETH SALISBURY—Region VII
JOHN H. KEYES—Region VIII

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price to members and affiliates one year $3.50, single copy 50 cents, to nonmembers one year $7.00, single copy 75 cents. Add $1.50 for postage to all countries outside the United States, Canada, and the Pan-American Union. Changes of address must be received at Society headquarters seven weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Laws: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Copyrighted, 1954, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulation. Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author and that date of publication be stated.

MECHANICAL ENGINEERING is indexed by the Engineering Index, Inc.

MECHANICAL ENGINEERING

Problems of the Thermal Barrier 966
Thermal Barrier—Over-All Effects 967
Thermal Barrier—Effects on Systems 970
Thermal Barrier—Effects on Airframes . . . 973
Liquid-Metal-Cooled Reactors . . . . *C. R. Stahl* 978
Boiling Heat Transfer:
What Is Known About It . . . *W. H. Jens* 981
Physics...Mother of Instrumentation *G. P. Harnwell* 987
Continuous Annealing of Steel Strip—
Controls for High-Speed Line . *H. C. Morrow* 990
The New Atomic Energy Law—
What It Means to Industry . . . *E. L. Hollis* 995
Theory of Maintenance of
Rolling Stock . . *R. R. Crane and F. B. Brown* 999

Editorial 965
Briefing the Record 1001

Waste-Wood Furniture Exhibit, 1001; Plastic Pipe, 1003; Reinforced-Plastic Truck Trailer, 1004; Air-Pollution Bibliography, 1005; Submarine Telephone Cable, 1005; Packaged Power Reactor, 1006; Mobile Electric Power Plant, 1006; 100-Hr Gas-Turbine Operation, 1008; Nuclear-Engineering Briefs, 1008; Engineering Developments, 1010

European Survey 1012

Rapid Precision-Swaging Machine, 1012; High-Precision Automatic Lathes, 1012; Profile Grinding With a Pantograph, 1013; High-Speed Press With Underdrive, 1013; Heavy-Duty Lathe, 1014; Compressed Air for Rock-Drilling, 1014; "Volumetric" Gas Turbine, 1014

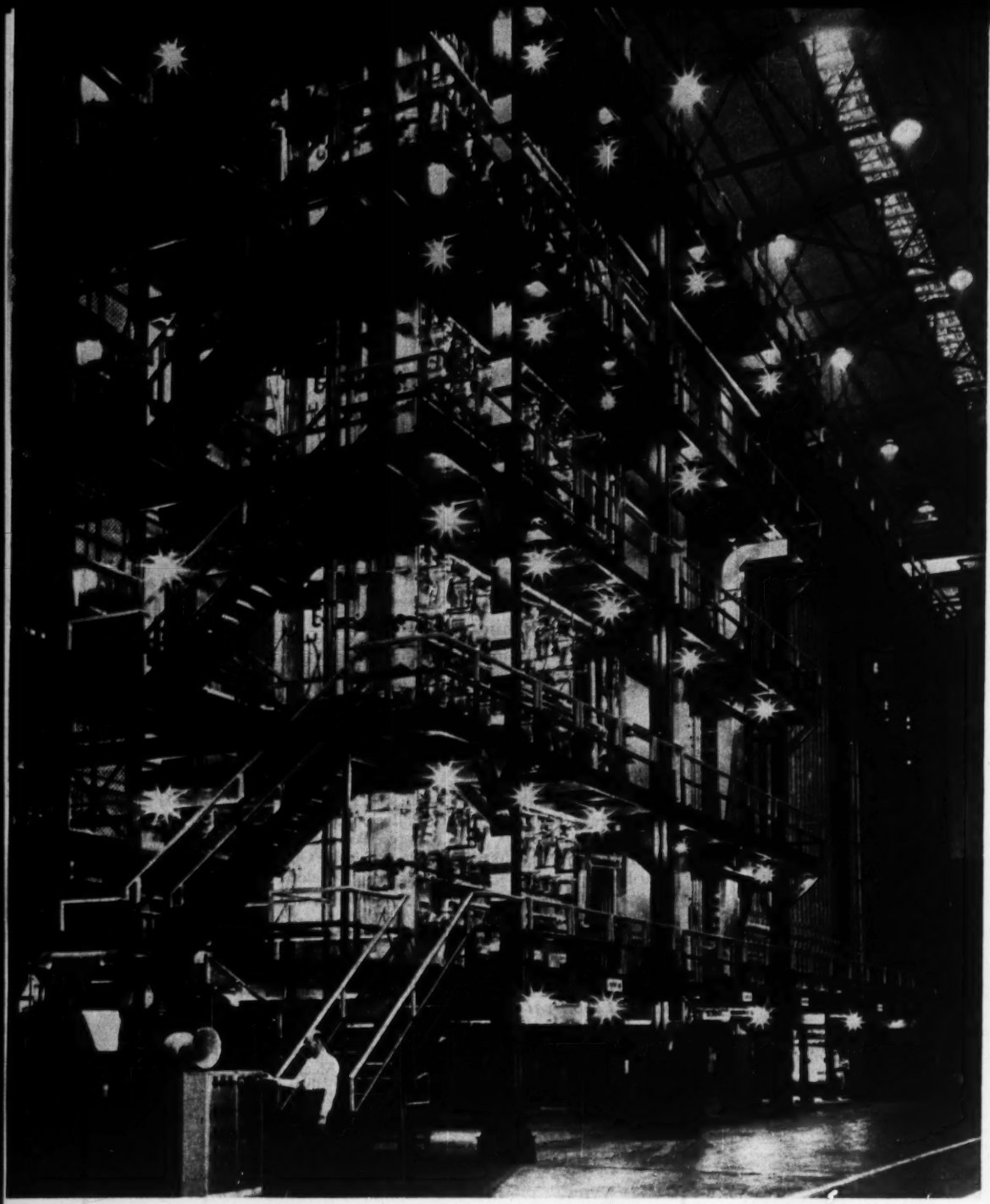
ASME Technical Digest 1015

Steam Power Generation, 1015; Gas-Turbine Power, 1016; Lubrication, 1018; Production Engineering, 1019; Machine Design, 1019; Instruments and Regulators, 1019; Petroleum Mechanical Engineering, 1022; ASME Transactions for November, 1954, 1030

Comments on Papers 1031
Reviews of Books 1036
ASME Boiler Code 1038
ASME News 1040

Engineering Education Meetings, 1040; EJC General Assembly, 1042; Petroleum Meeting, 1043; Lubrication Conference, 1044; Fuels Conference, 1046; IEC Prime Movers Meeting, 1047; Air-Pollution Meeting, 1048; Hoover Medal Awarded, 1049; ASME Ballots, 1049; ECPD Cincinnati Meeting, 1049; ASME Calendar, 1050; AAAS Meeting, 1050; Standardization, 1051; Atomic Energy Law Conference, 1052; ASME Executive Committee, 1052; Personnel Service, 1053; Candidates, 1056; Obituaries, 1056

Classified Advertisements 117 *Consultants* 122
Advertisers . . . 124



Continuous Annealing of Steel Strip

Entry end of furnace which cleans and anneals steel strip at a rate of 30 tons per hour, based on processing of 0.0010-in-thick × 30-in-wide material at a speed of 1000 fpm. A complete description of the process appears in this issue, pages 990–994.

Editorial

MECHANICAL ENGINEERING

December, 1954, Vol. 76, No. 12 . George A. Stetson, *Editor*

After 75 Years

BY THE TIME these brief comments are read, The American Society of Mechanical Engineers will have held its seventy-fifth annual meeting and will have embarked upon a year of celebration of its seventy-fifth anniversary.

Impressive changes have marked the passage of time since November, 1880, when the first ASME meeting was held. Among these many changes are two which affect the engineer most intimately. They are the spectacular growth of technology and engineering which the intervening years have witnessed, and the public recognition which the engineer has won as a result of this growth and its impact on the material well-being of his fellow men.

The engineer himself will be among the first to admit that the achievements with which he is credited were not the results of his efforts alone. For without the contributions of innumerable other persons—the scientists on the one hand, and a skilled and responsive labor force on the other, to name but two—all working in an expanding economy based on free institutions and free men—he would not have been able to exercise so effectively that catalytic influence typical of his profession. What the engineer has accomplished has been, in the words used by the Founders of the Society, diligently to promote "the arts and sciences connected with engineering and mechanical construction," and by success in that endeavor to command the recognition of the public.

If one were to compare the subject matter of the papers presented at the first ASME Annual Meeting with that to be found on the program of the seventy-fifth meeting—or, in fact, with the subject matter of this current issue of MECHANICAL ENGINEERING—he would find those contrasts that reflect the growth in technology which the intervening years have recorded. For example, there was much talk in 1880 of steam and even electrical power, but not a hint of atomic energy. High tribute was paid to the semiautomatic textile machines of the day, but there is no evidence that anyone seriously considered a grouping of metal-forming machines through which a workpiece could progress from its rough to its finished state. The economic significance of high productivity was clearly recognized, but no one had proposed the automatic factory. Indicating instruments had been in use for hundreds of years, but few if any recording and regulating instruments were known and there was but scant development of the field of instrumentation. Mechanical devices were numerous and ingenious, but electrical and electronic devices were yet to come. Bessemer steel was recognized as a great boon to industry, but most engineering materials were much the same as they had been for years, and aluminum, magnesium, vanadium, and a host of other metals and countless varieties of plastics and synthetic substances were laboratory curiosities or quite unknown. Great pride was taken in steam transportation by land and sea, but the steam turbine, the diesel engine, the automobile, the airplane, and the jet engine were yet to come.

Without derogation of the long list of able and distinguished men who have served ASME as president, it may be wondered if any one of their addresses has come quite so close to the ideal or can today be read with such profit and satisfaction as the address delivered at the first ASME Annual Meeting by the first President, Robert H. Thurston. If one were to compare the objectives and ideals and the means of attaining them with those stated in the current By-Laws of the Society, the differences he would find would be mostly in the words by which they are expressed. And if one were to compare Thurston's vision of the position of influence in the life of the nation that an engineer might aspire to, he would again find those areas in which we today would like to see members of the profession actively engaged. Technology changes, yes, but the goals, the ideals, the vision of what may be if only we can bring it to pass, remain very much the same as those of 1880.

Fortunate indeed is a professional society the pattern of whose history was set by a man of vision, of high ideals, and of sound engineering competence, and whose policy it has been since the start to form an association of men of high qualities, character, promise, and achievement. An anniversary affords an appropriate opportunity to take stock of the past and to plan farsightedly for the future. It is also a time for rededication of those now active in its affairs to the preservation of the heritage of the past. As Dr. Thurston said 75 years ago:

"We are now called upon to do our part in the work so well begun by our predecessors and so splendidly carried on by our older colleagues during the past generation . . . . Every member of the engineering profession has his share of this work, not only in his private capacity, but as a member of a great body of men of kindred pursuits, each of whom may be called upon to give to his neighbor of his own light, and to assist in promoting the general welfare."

Problems of the

Thermal Barrier

- *Over-All Effects*
- *Effects on Systems*
- *Effects on Airframes*

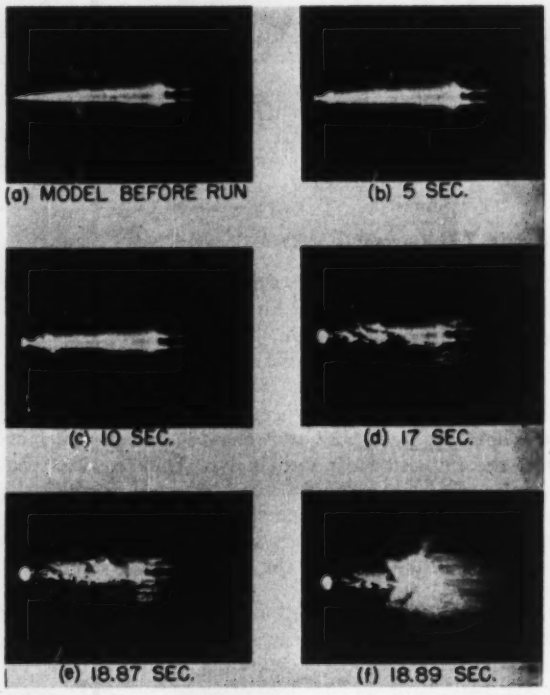


Fig. 2 Melting of a thin shell model in a wind tunnel due to aerodynamic heating at Mach 6.9 (McLellan)

SURROUNDING a moving aircraft is a relatively thin boundary layer of air in which the still air is accelerated to the velocity of the aircraft. The heating associated with the frictional effects in the boundary layer is rapidly dissipated in subsonic flight. In supersonic flight the effects become noticeable but are generally of little importance below Mach 2 because of the fact that flights usually are made in the stratosphere where the ambient temperature is —67 F under standard conditions. Beyond Mach 2 the effects become progressively more severe—the thermal barrier has been broached.

High temperatures are not entirely a new problem to aircraft. They have long plagued designers of gas turbines and have affected the airframe near engines and thermal deicing equipment. At speeds beyond 1500

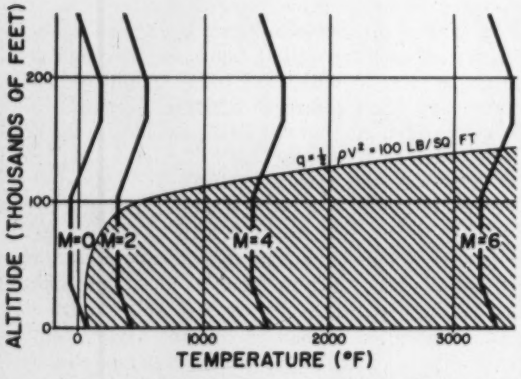


Fig. 1 The variation of temperature versus altitude at Mach numbers up to 6 are the nearly vertical lines. The temperature variation with altitude at Mach 0 is the NACA standard temperature. At higher Mach numbers the temperature versus altitude curves are simply displaced to the right, indicating that the temperature rise does not vary with altitude but only with Mach number. The temperature plotted is the temperature of the layer of air passing over the skin of the aircraft and is assumed to be 88 per cent of the stagnation temperature. It is apparent from these figures that we can't get away from high temperatures by flying higher. The possible flight limits for future supersonic aircraft are also shown by the curve, $q = \frac{1}{2}\rho V^2$, plotted at the altitude at which an airplane with a wing loading of 100 lb per sq ft would stall with a lift coefficient of 1. No reasonably proportioned airplane is likely to fly above this altitude (Adams).

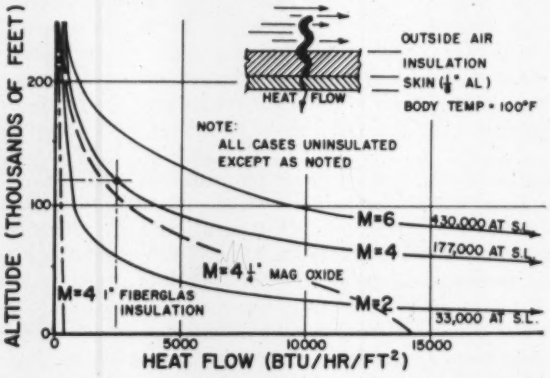


Fig. 3 The heat input into the airplane as a function of altitude for Mach Numbers 2, 4, and 6. At Mach 4, for example, the heat input at 120,000 ft, about 2000 Btu/hr/sq ft, is only a little over 1 per cent of the heat input at sea level, or 177,000 Btu/hr/sq ft. The dotted curves show the effect of insulating the outside skin of the aircraft. At Mach 4, 1/4-in. magnesium-oxide insulation reduces the heat flow slightly at high altitudes and markedly at low altitudes over an uninsulated surface. Insulation equivalent to 1 in. of fiberglas is still more marked and the effect of altitude is greatly reduced. With so high an available heat input, the outer surface of the insulation heats up to nearly the same temperature at any altitude and the heat flow through the insulation is then a function of the temperature difference and not of the heat input into the outer surface (Adams).

mph, however, the elevated temperatures caused by aerodynamic heating become an over-all design problem.

Two aspects of aerodynamic heating appear startling. First is the temperature rise shown in Fig. 1. For example, at Mach 5 aluminum melts, at Mach 6 steel melts. In Fig. 2 the melting of a thin-walled cone in a hypersonic wind tunnel vividly demonstrates the effects of aerodynamic heating. A second aspect is the quantity of heat produced as illustrated in Fig. 3.

The sonic barrier of a decade ago was pierced primarily through the efforts of aerodynamicists and propulsion engineers. Beyond Mach 2, the structures and equipment engineers face a barrier of ever-increasing dimensions at altitudes where air-breathing engines and lifting wings are still possible.

The ultimate effects of the thermal barrier upon aircraft performance are viewed differently. Some optimistically contend that a suitably designed airplane or missile may fly very fast at extreme altitudes where the density of air is practically zero and then proceed at reduced speed while passing through lower altitudes. During the short periods of flight in the denser regions of the atmosphere even very high stagnation temperatures may not do much harm if the structure has a great deal of heat capacity, if it is protected by a layer of insulating material, or if it is cooled.

Others have come to more pessimistic conclusions. Their contention is that large temperature increases and heating rates render any method of preventing the primary structure from heating up for more than a short period of time, at best, only palliative. Studies have shown that the weight penalties involved in insulating or cooling the structure are tremendous. Considerations of the use of insulation, heat storage, cooling, and other methods indicate that sooner or later the aircraft engineer will have to face the task of designing primary structure to carry loads while hot.

In subsequent sections of this survey, over-all problems which arise in pilotless and piloted aircraft are first considered. Individual problems associated with various systems are then presented. Finally, new aspects of structural design and analysis caused by aerodynamic heating are discussed and the associate weight penalties are considered.

Thermal Barrier—Over-All Effects

Pilotless Aircraft[1]

A vehicle traveling in a ballistic trajectory at very high speeds is in the relatively high-density air where heat transfer and drag are important for only a short time. The real problem arises in the re-entry phase of the trajectory, where, for a brief period, the vehicle is subjected to enormous values of heat transfer and it becomes of vital importance whether the boundary layer is laminar or turbulent. For the re-entry, a relatively heavy low-drag vehicle which decelerated very little was assumed in an example. The maximum laminar heat-transfer rate is over 2,000,000 Btu per hr per sq ft, which is on the order of 50 times that ordinarily encountered in modern boilers. The maximum rate for the turbulent boundary-layer case is 36,000,000 which is of the order of 1000 times that which is encountered in standard boiler practice.

Several possibilities of relieving the aerodynamic heating present themselves. Reverse thrust to decelerate the vehicle before it enters the high-density air would be usable if sufficient fuel could be carried along. However, an increase in initial weight of at least one order of magnitude would not be unlikely. The vehicle may also be decelerated at high altitudes by the use of a large drag-to-weight ratio. This is the mechanism by which small meteorites (0.04 in. in radius) reach the earth's surface even though they have much higher entry velocities than those considered for man-made vehicles. Application of the same principle to a large vehicle would require that the drag be very large at high altitudes even though the air densities are extremely small, so that the structure required would probably be large and heavy.

For some flight conditions the structure probably can be protected to some extent by use of an insulating material applied to the exterior of the vehicle. However, there are no insulating materials known which can stand up under the high temperatures, thermal stresses, and aerodynamic forces that are encountered at the higher Mach numbers.

Another possible approach is to cool the surface by some means, such as transpiration cooling where a fluid, possibly water, is forced through the surface. Although the use of a transpiration cooling system or, for that matter, any cooling system, involves considerable design complication both in the cooling system itself and in the vehicle structure, it is a promising approach.

As a further possibility, the structure of the vehicle may be used to absorb the heat and parts of the vehicle may be allowed to melt, if necessary. This process is one which occurs in nature for very large meteorites. Large meteorites reach the earth's surface because they are able to absorb large amounts of heat per unit of surface area. For these meteorites, the aerodynamic heat-transfer rates are high for a short time, but only a small part of the heat can be conducted to the interior so that melting occurs at the surface while the interior remains relatively cool. Between the very small and the very large meteorites which are able to reach the earth's surface, are many which are destroyed by the heat they absorb as they enter the atmosphere.

Model Tests. To explore the last possibility, an investigation was undertaken to melt models by aerodynamic heating in a hypersonic wind tunnel at Mach 6.9 using Wood's melt which melts at 158 F. For these tests the free-stream temperature was about —350 F while the stagnation temperature was about 700 F. The configurations used included a solid hemispherical-nosed cylinder, a solid cone-cylinder, a thin-walled cone, and a thick-walled cone. All the cone models had a 20-deg apex angle.

Typical results of the melting tests of the solid models are presented in Fig. 4. Photographs of the models as

[1] Summary of "Melting of Bodies Due to Aerodynamic Heating," by Charles H. McLellan (ASME Paper No. 54—A-57).

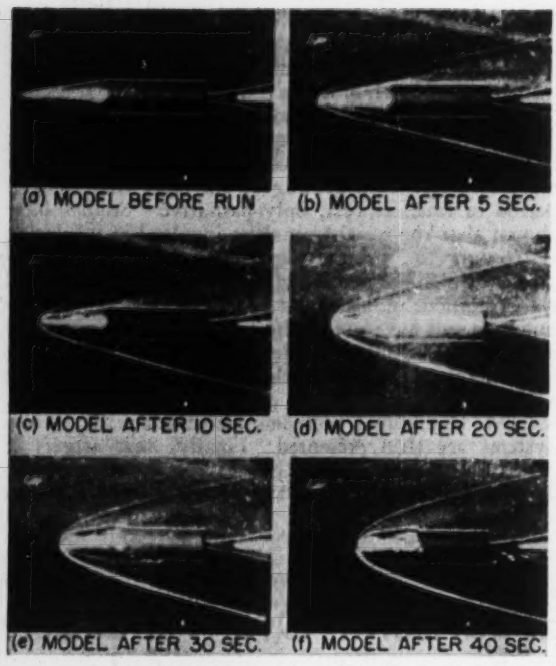


Fig. 4 Melting of a solid 20-deg cone-cylinder in a wind tunnel due to aerodynamic heating at Mach 6.9 (McLellan)

they melted were obtained from 16-mm motion-picture film. The tunnel tests were made at a constant Mach number, air temperature, and density.

The hemispherical-nosed model, as well as the cone-cylinder, were observed to start melting almost immediately with the start of the air flow in the nozzle of the wind tunnel. On the hemispherical-nose model, melting started at the center of the nose and rapidly spread to cover the entire hemisphere during the first 10 sec, after which the nose shape remained constant for the rest of the run. The stable shape was considerably blunter than the original hemisphere. On the conical-nosed models, melting started on the tip, producing an approximately spherical blunted nose, which grew in radius as it moved back on the cone.

In order to obtain conditions in which melting would occur on some part of the model other than the blunted nose, a thin-walled conical-nosed model was tested with results shown in Fig. 2. In contrast to the uniform melting which was observed on the solid models, the entire thin wall failed shortly after the melting of the outside of the wall had started. This indicates that the inner surface of the wall reached the melting point at approximately the same time as the outer surface.

Conclusions. Preliminary tests have shown that the melting is an orderly and reproducible process. Melting occurred only on the nose of the solid bodies in the tunnel because the heat-transfer rates were sufficiently low over the remainder of the bodies so that much of the heat could be conducted to the interior. In flight, where the heat-transfer rates can be very high, melting might also occur at parts of the body other than the nose regardless of the skin thickness. In tunnel tests melting did not appreciably alter heat-transfer rates.

Piloted Aircraft[2]

There are two basic ways to attack the aerodynamic heating problem. The first approach is to design the aircraft to endure the high temperatures. This might be possible at low Mach numbers with some structural materials and with simple equipment. It is the simplest solution from the airplane designer's point of view because it avoids the necessity for cooling systems except for the pilot, but it appears at the present time to present almost insurmountable problems of equipment development at even moderately high Mach numbers.

The second approach is to keep the airplane cool so that conventional designs can be used. Even here the airplane designer is faced with two choices. First is the insulation of the airplane and equipment with no provision for cooling. The success of this method depends on a low rate of heat rise and a short time of flight to keep the equipment below its limiting temperature. The second approach is to provide some form of cooling system.

Fig. 5 illustrates the first approach, that of using insulation without cooling. It shows the transient temperature of the structure, plotted against time of flight, for various altitudes, at Mach 4.

As to the second approach, some of the cooling systems that have been used in the past have been examined to determine their suitability for use in high-speed high-altitude aircraft, Fig 6. These cooling systems fall into three general classes—air-cycle systems, water-evaporation cooling systems, and fuel cooling. The latter is possible, of course, only in chemically fueled aircraft.

Hypothetical Aircraft. Now that we have seen what performance might be expected from cooling systems, let us examine the choices facing the designer of a hypothetical high-speed aircraft. This aircraft is assumed

[2] Summary of "Temperature Problems of Equipment in High-Speed Aircraft," by H. W. Adams (ASME Paper No. 54—A-131).

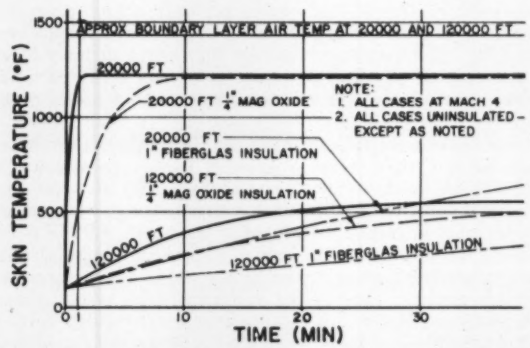


Fig. 5 At 20,000 ft the temperature of an uninsulated airplane skin reaches equilibrium in about 1 min; with 1/4-in. magnesium-oxide insulation it takes nearly 10 min; and with insulation equivalent to 1 in. of fiberglas, the temperature after 20 min is 425 F. At 120,000 ft with uninsulated structure, the skin temperature after 20 min would be about 510 F; with a magnesium-oxide insulation, about 390 F; and with insulation equal to 1 in. of fiberglas the skin temperature after 20 min would be only about 225 F. The reduction in equilibrium temperature from the boundary-layer air temperature of 1440 F to about 1240 F at 20,000 ft is due to radiation heat loss. At 120,000 ft, because of the lower heat input from the airstream, radiation reduces the temperature to 570 F (Adams).

to have a gross weight of 25,000 lb and a fuel weight of 12,500 lb. Three wing loadings of 100, 330, and 1000 psf, as shown in Fig. 7, have been assumed. It will be noted that the drag curves and the fuel-consumption curves are identical. This is because a fuel consumption of 3 lb/lb thrust/hr was assumed for all Mach numbers. This is about the present fuel consumption of jet engines with afterburners at low supersonic Mach numbers, and theoretical considerations indicate that if efficient air intakes can be developed, fuel consumptions of this order are still possible at high Mach numbers. At Mach 6 this fuel consumption would correspond to 0.26 lb/hp-hr which is not impossible considering the high-compression ratio associated with this speed.

Conclusions. Representative chemical and nuclear-fueled aircraft were studied with conclusions shown in Figs. 8 and 9.

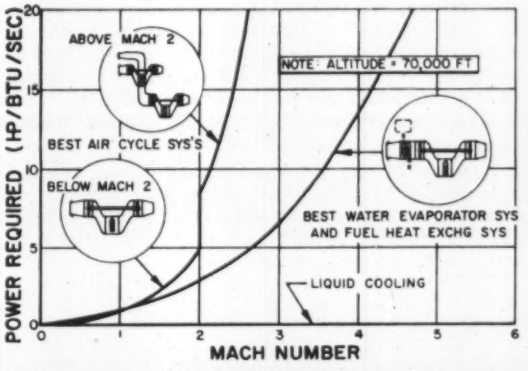


Fig. 6 Summary of the best cooling systems, from a horsepower standpoint, for altitude of 70,000 ft. Below Mach 2, the best air-cycle system is the ram turbine and blower system. Above Mach 2, the compound ram turbine and blower system is better. On this same basis, the water evaporator and the fuel heat-exchanger systems are equal and are better than air-cycle systems for all speeds above Mach 1 (Adams).

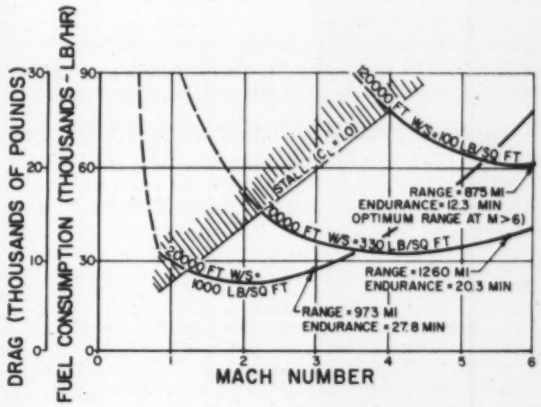

DRAG (THOUSANDS OF POUNDS)
FUEL CONSUMPTION (THOUSANDS - LB/HR)
MACH NUMBER
STALL (CL = 1.0)
20,000 FT W/S = 100 LB/SQ FT
RANGE = 875 MI
ENDURANCE = 12.3 MIN
OPTIMUM RANGE AT M > 6)
10,000 FT W/S = 330 LB/SQ FT
RANGE = 1260 MI
ENDURANCE = 20.3 MIN
5,000 FT W/S = 1000 LB/SQ FT
RANGE = 973 MI
ENDURANCE = 27.8 MIN

Fig. 7 Performance chart for hypothetical aircraft. The airplane with a wing loading of 1000 psf at 20,000 ft would have a stalling speed somewhat above Mach 1. Its minimum drag and fuel consumption occur at about Mach 2 and its maximum range occurs at about Mach 3. At 70,000 ft the airplane having a wing loading of 330 psf would have a stalling speed above Mach 2, minimum drag and fuel consumption at Mach 4.5, and maximum range at a speed of Mach 5.6. Note that this aircraft would have a range of about 1260 miles, which it would cover in 20 min. The aircraft flying at 120,000 ft with a wing loading of 100 psf would have a stalling speed of Mach 4, have its minimum drag at Mach 5.8, and its maximum range at some higher Mach number. At Mach 6 the range would be 875 miles for a flight time of 12 min (Adams).

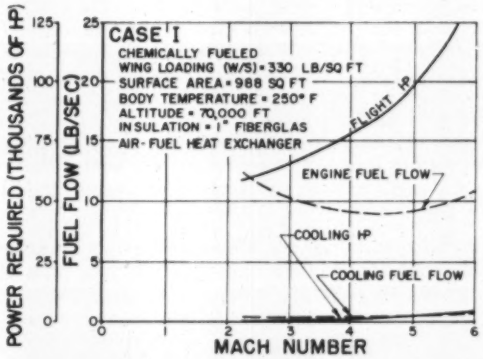


Fig. 8 Design summary for the chemically fueled aircraft with a wing loading of 330 psf flying at an altitude of 70,000 ft. The horsepower required varies from less than 60,000 hp at Mach 2 to above 120,000 hp at Mach 6. The engine fuel flow is on the order of 10 lb/sec. With the aircraft uninsulated, the entire engine fuel flow would be required to cool the airplane at Mach 3.5 and the cooling horsepower, assuming an air-fuel heat exchanger, would be about 25 per cent of the horsepower required for flight. If, as shown in this figure, the aircraft were to be insulated with insulation equal to 1 in. of fiberglas, the cooling horsepower would be only a few per cent of the horsepower required for flight and the fuel flow required for cooling would be on the order of 10 per cent of the engine fuel flow (Adams).

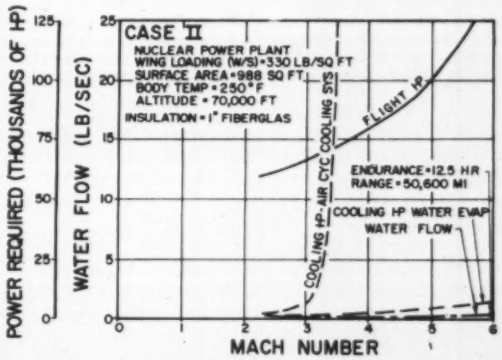


Fig. 9 The same data as used in Fig. 8 are presented for an insulated aircraft having a nuclear power plant, where fuel cooling is not possible. For an uninsulated aircraft, the cooling horsepowers start to rise rapidly in the region of Mach 2 if air-cycle cooling systems are used. If a water-evaporator system is used, the cooling horsepower equals the flight horsepower at about Mach 4.9 and the water flow would be such that the airplane range would be limited to about 2400 miles assuming half of the take-off weight of the airplane to be water. If, as in this figure, the same aircraft were to be insulated with insulation equal to 1 in. of fiberglas, the cooling horsepower would be on the order of 5 per cent of the flight horsepower; required water flow would be such that a range of 50,000 miles would be possible even at Mach 6 (Adams).

Turbojet Problems[3]

Although this discussion is confined to turbojet engines, by proper modification for the unique circumstances concerned, the data can be applied to other forms of air-breathing propulsion systems. We may assume that at present, man-carrying and some unmanned supersonic vehicles will be turbojet-powered for reasons of state of development, economy, and missions to be performed.

Compressor Problems. Having taken air on board the engine, it must now be compressed and this is where the temperature problem becomes acute as shown in Fig. 10. For instance, a sea-level static 9:1 compressor operating

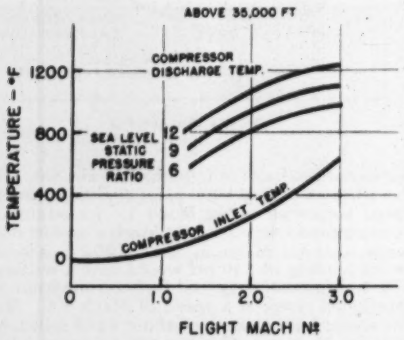


Fig. 10 Temperature rise through compressor at various flight Mach numbers for compressors of several sea-level static-design-pressure ratios operating above 35,000 ft on a hot day. For reference, standard day inlet temperatures are given in the lower curve. The sizable increase in temperature of the air as it passes from the inlet-compressor stages to the final stages is clearly evident and the rise is greater for the higher-pressure ratio machine. Data account for the decrease in effective compressor-pressure ratio due to aerodynamic heating at the inlet and are therefore accurately representative of actual temperatures which may be expected at the blades in the aft-compressor stages (Gardner).

at Mach 1 above 35,000 ft will receive inlet air with a total temperature of about 60 F and discharge the air at about 500 F. However, the same engine operating at Mach 2.8 receives air at about 650 F and discharges it at about 1100 F.

Considering the effect of temperature rise on metal strengths it is obvious that a much more limited choice of materials is available. Further, the vibratory stresses caused by blade-flutter problems are more likely to further complicate the design problem. Considering that a high-performance compressor may have 1000 blades exclusive of stators and that the failure of one blade can completely wreck the engine and possibly destroy the airplane and crew, the compressor appears as an old problem which has become more critical and difficult of solution under high-temperature conditions.

In addition, in spite of thermal expansion and creep the designer must provide for the small clearances between blade tips and the casing which make for high compressor efficiency. A further problem arises in providing satisfactory seals to prevent hot-air leakage to the interior of the engine. Thus the increase of problem areas in future compressor designs cannot be overemphasized.

Turbine Problems. The turbine is the most critical engine component with respect to temperature. The maximum operating temperature which the turbine can withstand automatically acts as a limit to the amount of energy in the form of fuel which can be added upstream of the turbine. At Mach 1 a turbine-inlet temperature increase from 1600 F to 1800 F allows an increase of approximately 22 per cent in fuel addition per pound of air, while at Mach 2.5 the same 200-F increase in turbine-inlet temperature allows a 44 per cent increase. This fact has spurred the quest for higher allowable turbine-inlet temperatures.

In the case of the engine designed for relatively low speeds, the difference between compressor-discharge temperature and turbine-inlet temperature allows sufficient differential to add enough fuel to provide compressor power and a significant amount of useful thrust for propulsion. As much as two thirds of the energy represented by this temperature differential is required to power the compressor.

Now consider the high Mach number engine operating at the same turbine-inlet temperature but at a much higher compressor-discharge temperature. The differential, representing energy available for the compressor and thrust, has been reduced considerably. Power requirements to make up compressor and turbine losses, although probably reduced, will still consume a major portion of the available energy and can conceivably be of such magnitude as to allow no energy for thrust requirements. Therefore, excluding the use of afterburners and other thrust augmentation devices, it is readily seen that in order to provide the same compressor discharge-turbine inlet temperature differential as was provided by the low-speed engine, increased emphasis must be applied to allowing higher maximum turbine-inlet temperatures.

To sum up the over-all engine problem and to provide a temperature frame of reference for the engine designer as well as the airframe and accessory designer, practical temperature ranges to be expected are shown in Fig. 11.

Conclusions. Today's compressor designer must now provide inlet-stage blades which might run at a temperature which yesterday's designer only considered for

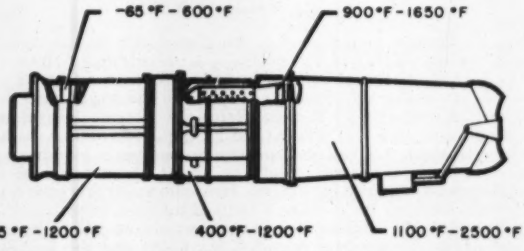


Fig. 11 Range of temperatures which turbojet engine components may experience (Gardner)

[3] Summary of "An Introduction to the Thermal Problems of Turbojet Engines for Supersonic Propulsion," by Alfred J. Gardner (ASME Paper No. 54—A-155).

last-stage blades. Last-stage blades must operate under conditions as severe as the turbines endured in early engines. As allowable turbine-inlet temperatures are raised, combustor liners and tubes must resist the severe temperature extremes now applied to turbines. The turbine itself, long the real hot bed of thermal difficulties, forces the materials and design engineers into areas of effort where arithmetic performance progress requires geometric effort expenditures. Downstream of the turbine, the constant quest for higher performance and lighter weight sustains the challenge to the designer of aft sections, afterburners, and propulsion nozzles.

Propulsion Installation Systems[4]

A multiplicity of problems are involved external to the engine itself. These items do not, of themselves, contribute to the thrust of the propulsion system, but are essential to support that engine. If improperly designed or executed, they may detract greatly from the mission effectiveness of the aircraft or missile.

Fuel Systems. It is obvious that heat will be conveyed to the stored fuel of a supersonic aircraft, with fuel stored in either the wing or fuselage. With hydrocarbon fuels certain losses will be encountered unless pressurization is utilized. For example, a hypothetical Mach 2 bomber, in sustained flight at 40,000 to 50,000 ft, would lose about 18 per cent of its fuel due to vaporization. This fuel is assumed to be initially at 100 F, with no tank pressurization. The addition of $^1/_{16}$-in. cork around the tanks would reduce this loss to 8 per cent, again with no pressurization. However, with insulation and 4 to 5 psi pressurization, the fuel loss is negligible. Other configurations than that investigated might not be so favorable, and higher fuel-tank pressures might be necessary.

While insulation is important, it could penalize the mission of the aircraft. It would be necessary for particular aircraft to perform the laborious calculations of a "range trade," that is, a determination of reduction in range due to insulation (taking up space which could be utilized for fuel) compared to that due to loss of fuel.

The large quantity of fuel aboard supersonic aircraft is looked at with covetous eyes by the engineers of many systems, as a panacea for their supersonic problems—the fuel system is the ideal heat sink, they say. However, the fuel-system designer has more than his share of problems under conditions of supersonic flight, without anyone else adding heat to the fuel. It must, in some instances, be so used—but all such heat additions must be carefully integrated into the design of the aircraft.

Lubrication Systems. Lubrication systems must be predicated upon some external mechanism of cooling the oil in addition to operation at the extremely high altitudes of which supersonic aircraft are capable. Oils capable of sustaining high temperatures should have properties of noninflammability and retention of lubricity. An ideal oil for modest supersonic speeds should be operational in the temperature range from about —65 F to 800 F.

The development of high-temperature oils, however, is not the total solution to the problem, since it is necessary that bearings or other devices which are lubricated operate at the very high temperatures. The possibility of designing main bearings to have their own independent oil system, and hence eliminate pumps, has merit. Such a system might possibly involve the substitution of air, graphite, or molybdenum disulphite or lubrication.

[4] Summary of "Effect of Supersonic Flight on Power-Plant Installation Systems," by R. B. Keusch (ASME Paper No. 54—A-156).

This survey was prepared by George Gerard, Assoc. Mem. ASME, Assistant Director of Research, College of Engineering, New York University, and George T. Hayes, Mem. ASME, manager, Washington Office, Stanford Research Institute. It was contributed by the ASME Aviation Division and constitutes a review of the Symposium on the Thermal Barrier presented at the Annual Meeting, New York, N. Y., Nov. 28–Dec. 3, 1954, of The American Society of Mechanical Engineers. Sessions were cosponsored by the American Rocket Society, Society of Automotive Engineers, and the ASME Applied Mechanics Division.

A review of this type can hardly do justice to the individual papers presented. Therefore a special publication entitled, "Thermal Barrier Symposium" has been prepared and is available from ASME Order Department, 29 West 39th Street, New York 18, N. Y. In addition, separate pamphlet copies of each of the papers are also available.

Air-Induction Systems. Of particular significance in the installation of a supersonic air-breathing engine, is the problem of getting air delivered efficiently to the engine. Supersonic operation must insure that the shock waves generated at the inlet be properly positioned in order to obtain high ram recovery, low airplane drag, and even pressure and velocity distribution across the compressor face (or burner inlet for ramjets). The inlet may be of great help in obtaining power for supersonic flight; for instance, at Mach 3, the compression across the inlet shock wave can be about 18 to 1.

As speeds increase, optimization of the air-induction system over the speed range of the vehicle becomes imperative. In the field of variable-area inlets, the need for data, which can be developed into practical installations jointly by the aircraft, engine, and controls people, is a very present one.

Cooling Systems. The acuteness of the problem of cooling the engine and its associated systems stems from the lack of suitable noncritical materials which will withstand the high temperatures encountered in high Mach aircraft. Not only must the power-plant installation itself be cooled to obtain satisfactory performance of the engine and accessories, but also the structure and aircraft skin surrounding the power plant must be kept within temperature limits.

In addition to aerodynamic heating, the cooling problem of a supersonic aircraft power-plant installation is aggravated by the following considerations: The larger engines to be used in a supersonic aircraft and missiles have, in many cases, greater compression ratios and hence increased temperatures of the engine case over the last few stages of the compressor. The use of cooled turbine blades and afterburners (with the temperature of the latter running as high as 3500 F) will result in much higher temperatures for the "hot" parts of the engine.

Conclusions. The power plant and its installation systems, with increasing aircraft speed, account for in-increasingly larger percentages of the aircraft weight. The fuel system has been assessed as being particularly critical. Supersonic speed adds heat to the fuel system in such quantities that it gives the fuel-system designer many problems; the fuel system is not the ideal heat sink which, at first, it might appear to be. Other power-plant-installation-system problems demand early consideration in aircraft design, for compromise in the solution of these problems, due to their high percentage effect on the range of the aircraft, may well result in compromise of the total mission.

Cooling Systems[5]

Cooling of crew compartments and electronic equipment becomes more important and, at the same time, more difficult as airplane speeds increase. A sharp increase in capacity required from the cooling system takes place when the surrounding air becomes too hot to be a convenient direct heat sink. Heat sinks which can be found in the airplane are structure and fuel. The airplane structure itself can be used satisfactorily for a short duration where its thermal lag and capacity are sufficient and cooling off follows a brief period of excessive temperatures. For any flight longer than a few seconds, the whole structure will reach too high a temperature to be useful. Fuel is an attractive heat sink and it can be used conveniently if a heat exchanger between the fuel and the air is used downstream from the fuel pump. Unfortunately, the claim for fuel as a heat sink is made by the engine manufacturer for oil cooling and, so far, the air-conditioning engineer has not been able to obtain fuel for his purposes.

Artificial Heat Sinks. As there seem to be no other heat sinks present in the airplane, it is necessary to create an artificial one with the following properties: Absorb heat at the proper temperature level, absorb the highest possible amount of heat at the smallest possible weight and volume penalty, and be easily available and have no poisonous or highly corrosive properties.

It seems that plain water is superior to other substances on the bases of heat absorption capacity, availability, and chemical properties. The superiority of water is so great in these respects that the use of other materials having lower boiling-point temperatures at altitude is rarely justified in aircraft applications.

A typical air-cycle simple system employing a water evaporator is shown in Fig. 12. This type of system is installed in the X-3 high-speed research airplane. As can be seen from the lines of cooling-air temperature and boiling-water temperature, the system can operate with the turbine-inlet temperature considerably below cooling-air temperature.

Conclusions. Cooling the supersonic airplane is so important in terms of performance of the airplane that the optimum system can be achieved only through the co-operative efforts of airframe and equipment designers starting with the preliminary design stage and continuing through the final acceptance of the airplane.

Logical analysis of the cooling problems of a supersonic airplane led to the simple water-evaporative system, which, in its basic concept, can find application in high-speed aircraft of the present and for some time in the future.

[5] Summary of "Personnel and Equipment Cooling in Supersonic Airplanes," by J. Makowski and V. L. Whitney, Jr. (ASME Paper No. 54—A-206).

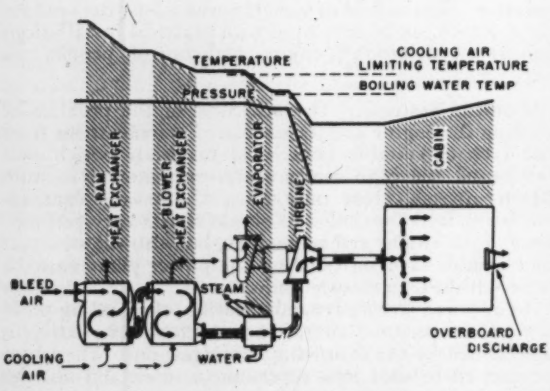


Fig. 12 Simple air-cycle air-cooling system with water evaporator. Ram heat exchanger removes portion of heat from bleed air followed by blower heat exchanger. Former depends upon airplane speed, the latter on engine setting, and therefore combined effectiveness is high. Evaporator is of brazed aluminum construction with extended surface on both air and water sides (Makowski-Whitney).

Human Problems[6]

Altitudes so high that human life is no longer possible without artificial aids may now be reached within a few minutes, and the full range of tolerable temperatures are met within a single flight. Extremes in accelerative forces leading to loss of consciousness or to death may be encountered during maneuvers.

One of the most important ways of improving flight safety and combat efficiency is to design equipment in terms of human capabilities and limitations. Aeronautical engineers should have an understanding of the sense organs and the characteristics of human perception, if satisfactory information is to be supplied to the pilot. The environmental conditions relating to temperature, humidity, toxic gases, and many other factors must be considered or physiological limits may be exceeded. Thus there is great need for more effective collaboration between the engineering and biological sciences.

Oxygen want at high altitudes gives rise to a progressive and insidious deterioration of performance. Although cabin-pressurization and pressure-breathing equipment provide satisfactory solutions, much remains to be done in improving the comfort and reliability of such advances. Sudden loss of pressure is serious, especially the symptoms related to aeroembolism which may occur during explosive decompression. The visual problems encountered at very high altitudes have introduced a number of unusual factors which are being brought under control by redesign of cockpit-illumination systems and other aids to the pilot.

The adverse stimuli relating to high-speed flight center around the accelerative forces which build up rapidly during sudden maneuvers, especially during combat flying. The effect of body position on tolerance to ac-

[6] Summary of "Human Problems Associated With High-Speed and High-Altitude Flight," by R. A. McFarland (ASME Paper 54—A-230).

celeration are shown in Fig. 13. Some protection can be afforded the pilot with anti-*g* suits but the limiting factors remain serious ones and all pilots should be indoctrinated in regard to their physical responses from such maneuvers. The visual and motor reaction times of pilots impose serious limitations in high-speed aircraft as illustrated in Fig. 14. The most satisfactory methods of designing the controls of modern aircraft, to come within the range of human capabilities, is deserving of further research.

Human tolerance for heat and cold is outlined so that aeronautical engineers might have a better understanding of design problems related to cabin atmosphere. The hazards resulting from noxious gases and vapors are also considered. The need for air-crew indoctrination in the effective use of equipment is emphasized as well as the need for airmen to understand their own physical limitations while in flight. Finally, the need for more effective collaboration between the biological and engineering sciences is stressed in regard to improving the man-machine systems in high-speed high-altitude flying which will be encountered in the thermal barrier.

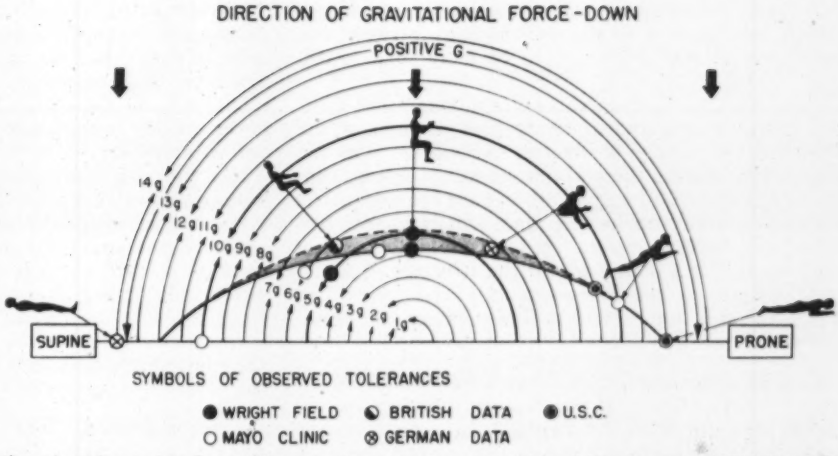


Fig. 13 Effects of body position on tolerance to accelerations of 10 sec or more (McFarland)

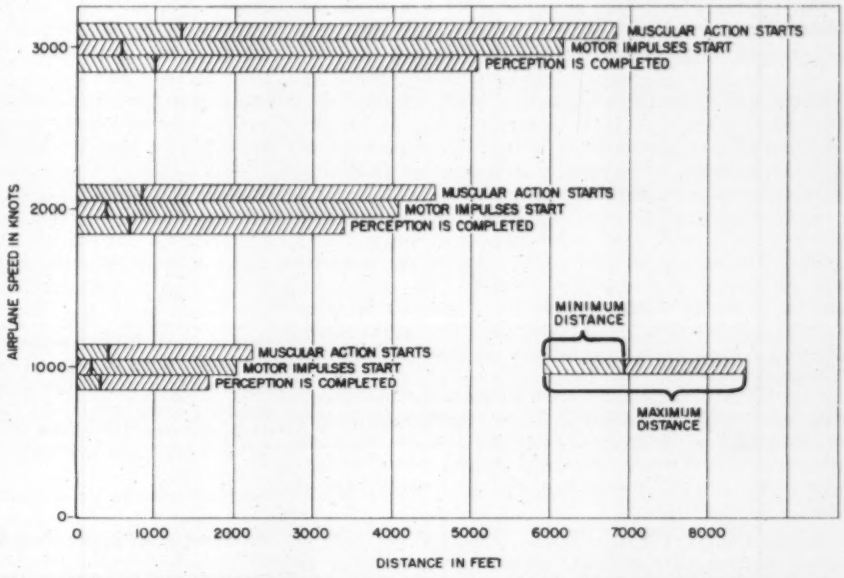


Fig. 14 Distances traveled before a pilot perceives a visual stimulus and initiates a muscular response. Minimum distances represent a bright visual stimulus in the line of sight when subject is forwarned. Maximum distances represent a faint stimulus slightly out of the exact line of vision without warning (McFarland).

Thermal Barrier—Effects on Airframes

Structural Problems[7]

Thermal Stresses. The wing of a supersonic airplane is heated only over its surface and its interior remains comparatively cool. Under these conditions the expansion of the material of the hot surface tends to force an expansion of the cooler interior which opposes such action. The resulting thermal stresses are compressive in the warm outer regions and tensile in the cool interior.

As a comparatively simple example, heating was assumed to be caused by a uniform speed of Mach 3.1 at an elevation of 50,000 ft, with a uniform initial temperature of 60 F. The wing structure was assumed to consist of two $^3/_8$-in-thick steel cover plates connected by a number of 0.1-in-thick steel shear webs.

After 200 sec of flight the cover plates reached 540 F while the middle of the web was at only 110 F. At that

[7] Summary of "The Thermal Barrier—Structures," by N. J. Hoff (ASME Paper No. 54—A-207).

time the maximum stress in the structure was the longitudinal tensile stress in the web midway between the flanges which was calculated to be more than 70,000 psi.

When tensile stresses of this order of magnitude actually appear in the comparatively cool portions of the structure, the danger of fracture is evident. On the other hand, extreme thermal stresses in hot regions cannot be maintained for any length of time because plastic and viscous deformations take place which immediately reduce the thermal stresses. It seems advisable, therefore, to provide possibilities for the structure of supersonic aircraft to deform permanently and thereby to escape thermal stresses within limits where safe operation is still possible.

Thermal Buckling. As a slender column is heated, its length would increase if the distance between its end points were not fixed, for example, by a rigid testing machine. The shortening due to the compression must balance the extension caused by heating and therefore the compressive force can be calculated. The highest thermal stresses are likely to occur with a material for which the product of Young's modulus and the coefficient of thermal expansion is the greatest.

The column will remain straight until the force becomes equal to the Euler buckling load; beyond this load bowing occurs. In a numerical example for the buckling of a steel column, a change in temperature of 68.6 F was found to be equally as dangerous as a compressive stress of 14,400 psi.

When the deviations from straightness due to buckling increase sufficiently, the combination of normal and bending stresses exceeds the yield point of the material and permanent deformations develop. As large-scale waviness in the walls of high-speed aircraft is most detrimental to the development of the proper aerodynamic forces, more information on thermal buckling is urgently needed.

Experiments carried out with electromagnetic induction-heating units produced large, permanent bulges in the covers of box beams representative of the wing structures of low supersonic-speed aircraft. Solid wedge-type wings showed waviness along the leading edge as may be seen in Fig. 15.

Creep Under Tension Loads. Besides the loss of strength of metals at high temperatures, creep is an important aspect of their temperature behavior. If a fighter spends only a few hours of its total flying time at supersonic speeds, and if a guided missile is designed for a flight of only a few seconds or a few minutes, there is every reason to allow stresses in the structure that cause creep deformations of a few tenths of a per cent in an hour. If this is not permitted, the allowable stresses must be chosen extremely low when the temperature of the structure is high and in consequence the airplane or missile will become unduly heavy. Creep rates of this order of magnitude are unprecedented in the design of structures and machinery. The creep rates studied extensively by the designers of heat-power equipment in the thirties were measured in a few hundreds of a per cent in 10,000 hr.

Fig. 15 Waviness along the leading edge of a solid wedge-type wing after exposure to elevated temperature (Hoff)

In a three-bar framework containing a vertical member as well as two members inclined at 60 deg, the vertical member carries 80 per cent of a vertical load when the structure is elastic. For an ideally plastic material, the share of the vertical bar is reduced to 50 per cent. These results indicate that the stress is distributed more evenly when the structure creeps. For this reason stress concentrations are likely to be less severe in the presence of nonlinear creep than in a material following Hooke's law.

Creep Buckling. When a bar is subjected to compressive rather than tensile loads, any slight initial curvature of the center line of the column gives rise to bending moments. Creep caused by the bending moment increases the curvature and hence the deviation from the straight line. A vicious circle begins, therefore, in which creep is increased by the increased deviations from the straight line and vice versa until the column folds up and becomes useless for structural purposes.

The creep-buckling process takes place under any compressive load however small. It lasts much longer if the load is small. One cannot talk, therefore, of a critical load or of a critical stress in creep buckling. The significant quantity is the critical time, that is, the time necessary for the column to buckle. The structural designer must make sure that the critical time of his column is greater than the required lifetime of the structure.

Conclusions. The novel feature of the behavior of structures at high temperature is the time-dependence of failure. Both in tension and compression the structural element fails under any load if it is maintained for a sufficiently long time. In this respect structures at high temperatures differ fundamentally from those used only at ordinary temperatures. The designer of supersonic aircraft has to get used to the idea that each structural element must be calculated for a definite lifetime.

Minimum-Weight Problems[8]

Structural Configurations of Minimum Weight. To obtain a structure of minimum weight within the limited geometry of thin supersonic wings, the skin acts as the main load-carrying member. As a result, stringer-panel construction is no longer universally used. In its place, various forms of sandwich construction, multicell construction, and post construction have been developed.

To evaluate the newer forms of construction from a minimum-weight standpoint, analytical methods are used. Both the compression cover and supporting structure such as ribs, webs, and posts are considered in the analysis. After the minimum-weight designs have been established, it is then possible to compare the various types of construction on a common basis. From this, the ranges of efficient structural application of each form can be determined. The results of such an analysis are shown in Fig. 16.

[8] Summary of "Some Structural Aspects of Thermal Flight," by George Gerard (ASME Paper No. 54—A-40).

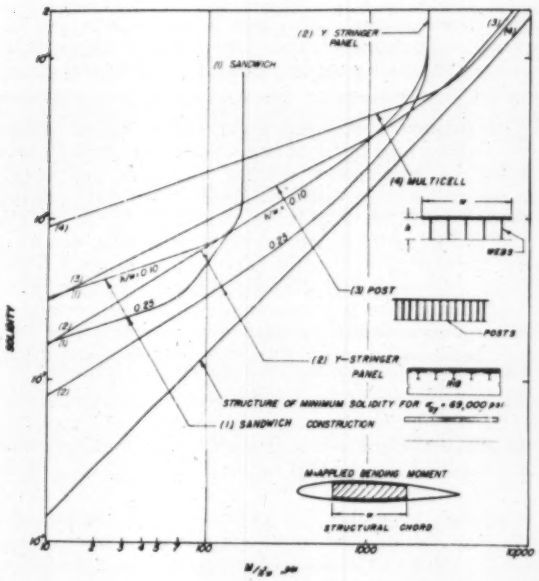


Fig. 16 This chart indicates the relative weights of various forms of wing and tail construction for 75S-T aluminum alloy. It represents a comprehensive analysis in which the theoretically minimum weight designs of each form of construction are compared on a common basis. It can be observed that at high values of M/h^2w, representative of thermal flight, multicell and post construction are more efficient structurally than Y stringer-panel construction (Gerard).

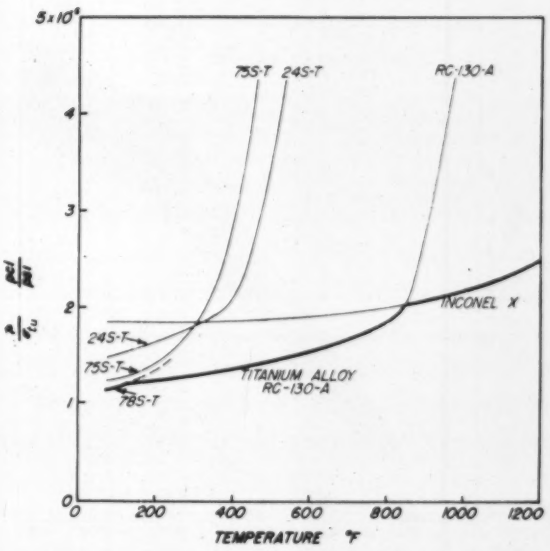


Fig. 17 Weight-strength ratios for short-time tension loading of various alloys (ρ = density, σ_{tu} = ultimate tensile strength). Note that titanium alloy RC-130-A is efficient at room temperature and retains this efficiency up to 800 F (Gerard).

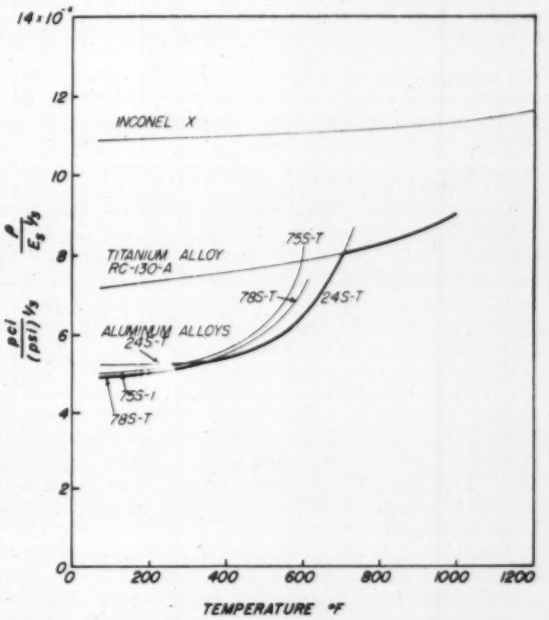


Fig. 18 Weight-strength ratios for short-time compressive and shear loading of various materials (ρ = density, E_s = secant modulus at yield). In contrast to the tension case, aluminum alloys are superior to titanium up to 700 F (Gerard).

Relative Weights of Materials. The second part of the minimum-weight problem requires evaluation of various materials which may be used at elevated temperatures. The weight-strength evaluation of tension materials is shown in Fig. 17.

Components subject to compressive and shear loads are generally governed by buckling considerations. It is generally efficient to use the yield strength as the allowable stress for heavily loaded thin wings. Therefore a weight-strength evaluation based on plastic buckling at the compressive yield stress is shown for several materials in Fig. 18.

In contrast to tension loading, aluminum alloys are superior for compression and shear up to temperatures of almost 700 F. Therefore the apparent superiority of titanium alloys for short-time tension up to 700 F must be balanced carefully against the superiority of the aluminum alloys for short-time compression and shear up to 700 F.

Relative-Weight Analysis. The natural growth trends of future aircraft are difficult to establish with any degree of accuracy. Therefore an approach is used in which the weight increases due to elevated temperatures are isolated from the natural growth trends. This has been accomplished by considering the relative weights of two aircraft designed to the same performance specifications; the reference airplane is designed for room-temperature conditions whereas the other is designed for elevated-temperature conditions on the basis of short-time strength data.

The increment in structural weight due to elevated temperatures must be multiplied by a suitable growth factor. This factor accounts for the increased propulsive and aerodynamic requirements to achieve comparable performance of the room and elevated-temperature aircraft. Therefore the average relative weight of tension, compression, and shear components was multiplied by representative growth factors as shown in Fig. 19. It can be observed that tremendous weight penal-

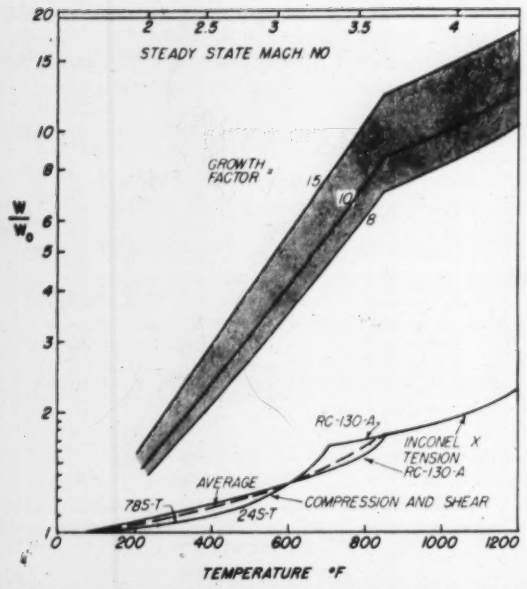


Fig. 19 Relative weight of aircraft designed for thermal flight (W) as compared to same aircraft designed on basis of room temperature (W_0). In this comparison, 78S-T was assumed for the room-temperature aircraft while for the thermal-flight aircraft the average trend based on the most efficient materials for a given temperature was used (Gerard).

ties are apparently involved in the design of aircraft for elevated temperatures in terms of what is now required for the normal temperature operation of transonic aircraft.

Life Expectancy of Aircraft. A new and significant aspect of thermal flight is the time-dependent creep deformation which occurs under applied load. Depending upon the service use of the aircraft, various criteria, such as stress rupture, creep buckling, initiation of third-stage creep, and specified deformations such as 0.02 strain, may be used to indicate the time of retirement of major components of the aircraft structure.

With aircraft at normal temperatures, it is well known that intermittent stresses due to gusts form the basis for limited fatigue-life expectancy. Although relatively little is known about gust conditions in the upper atmosphere, calculations indicate that under conditions of a 30-fps gust, the resulting stresses may be approximately 50 per cent of the 1 "g" stress level under thermal flight conditions.

Available data on alternating stresses under elevated-temperature conditions indicate that when the alternating stress level is a fraction of the mean stress, the creep curves remain unchanged to a first approximation. Since the alternating stresses due to gust loads appear to be relatively small, gust loadings may not decrease to any appreciable extent the life expectancy based on the mean stress levels.

To predict the life expectancy of aircraft under elevated temperature conditions, it is necessary to determine the time required to satisfy a given failure criterion under conditions which involve both varying stresses and temperatures. The initial information for the life-expectancy analysis consists of basic creep data for the material and the relative frequency distribution of applied stress and temperature which the airplane is to experience. To determine the life expectancy, a hypothesis is suggested which combines both the loading and physical-property data.

Conclusions. Sustained flight in the region where aerodynamic heating is of importance may be seriously limited by tremendous weight penalties. Although the upper limit for utilization of current engineering materials is in the neighborhood of 1800 F, the weight penalty due to decreased material properties resulting from aerodynamic heating may limit sustained flight to the region below 800 F, which corresponds to a Mach number of approximately 3.5. Flight at higher Mach numbers would be limited to operations of very short duration in order that the structure would not aerodynamically heat up to the steady-state temperature.

In connection with the weight problem, it appears that use of the newer types of construction may result in substantial weightsavings for the high-solidity structures required for thermal flight. Under thermal-flight conditions, creep will be the determining factor in establishing the usable life expectancy of the aircraft. To design the airframe for an unlimited life will, even if possible, result in additional weight to the already tremendous weight penalties incurred. Therefore limited life expectancy of aircraft designed for thermal flight may be expected as one solution to this problem.

Design Problems[9]

Creep Effects. The weight penalties that accrue from using long-time creep data are compared with those that develop using short-time data in Table 1.

Table 1 Comparison of Weight of Materials at 400 F With Aluminum at 75 F

	Per cent increase	Per cent increase — Long-time loading—100 Hr	
	Short-time loading	2 per cent deformation	Rupture
Aluminum	65 per cent	280 per cent	230 per cent
Titanium	23 per cent	39 per cent	37 per cent

To some extent, if either the temperature or the stress level is low, creep can be taken care of by merely reducing the allowables. At the higher temperatures and higher stress levels this leads to such large reductions in material allowables and imposes such large weight penalties that it is no longer feasible and the use of creep data in design becomes mandatory.

A comparison of creep data for wrought and cast materials shows that at the higher temperatures some cast materials have larger allowable creep stresses than wrought. If this proves to be generally true, it could mean a radical change in design and fabrication methods and lead to the economies associated with castings.

Temperature gradients, stress variations, thermal-induced stresses, stress and thermal cycling, stress-strain-temperature-time histories and many other factors affect both the stress distribution and the allowable stresses the various components will carry; for example, see Fig. 20.

Material Stability at Temperature. In general, most

[9] Summary of "Problems in the Design of Aircraft Subjected to High Temperature," by F. R. Steinbacher and Louis Young (ASME Paper No. 54—A-100).

structural materials lose stability and deteriorate at an accelerated rate at elevated temperatures. The deleterious chemical reactions that cause corrosion and loss of stability progress more rapidly at elevated temperatures. Further, the added elements which increase the strength and stability of a material may, at certain temperatures, either precipitate out or unite chemically with other elements and thereby prevent their further functioning in the intended manner.

Losses in strength due to corrosion are generally controlled by either coating the exposed surfaces to prevent the basic alloy from contacting the atmosphere or by adding elements that retard corrosion. At extreme temperatures (above 2000 F) there is a point beyond which alloys, no matter how skillfully blended, can no longer be considered structural material.

Beyond metals, the engineer must turn to refractory ceramics, particularly oxides of aluminum, magnesium, silicon, and zirconium. Already fully reacted with oxygen, these oxides can resist corrosive atmospheres and do not weaken appreciably until near their melting points which may be as high as 5000 F.

Thermal Stresses. Thermally induced stresses depend on the temperature gradient and thus they cannot be reduced or eliminated by merely adding more material. Such stresses are produced by differential expansion; consequently, it would be ideal if a structural material could be found or developed which has zero coefficient of expansion. For such a material no thermal stresses would develop regardless of the temperature distribution.

Nickel, when added to steel in the proper proportion, reduces the coefficient of expansion. For example, an alloy with 43.5 per cent nickel has a coefficient of expansion one half that of steel and retains this low coefficient up to 800 F. The development of low-expansion alloys might well make the difference between a practical aircraft and a structure too heavy to fly. At present no other metallurgical contribution to high-speed flight appears to offer greater promise or is more within the realm of possibility.

New Criterion of Structural Safety Required. In the design of aircraft structures, a margin of safety is required to take care of variations in materials, manufacturing techniques, and design uncertainties. The present factor of safety of 1.5 is based on load-carrying ability. In a high-temperature aircraft, however, four important variables are involved: Creep or creep rates, time, temperature, and stresses, any of which can be critical. Fig. 21 shows how confused the margin of safety concept becomes when creep factors are considered.

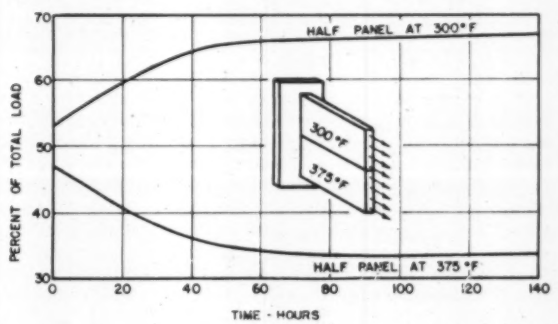


Fig. 20 Redistribution of load due to creep in a simple panel of 75S-T6 aluminum alloy. Panel is so loaded and restrained at the ends that each portion is forced to deform at the same rate—a condition not too far removed from that of tension surface of wing. For simplicity, thermal-induced stresses are ignored. The hotter portion creeps faster than the cooler portion and therefore gradually unloads (Steinbacher-Young).

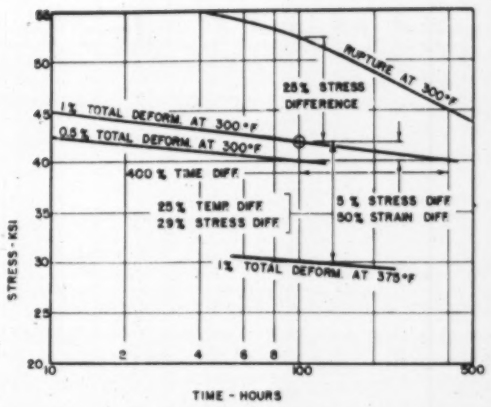


Fig. 21 Creep curves for 24S-T3 showing various ways of applying a safety factor and how allowables are affected. A stress of 42 ksi produces a total deformation of 1 per cent in 100 hr. Note that a 5 per cent reduction in stress permits either using the structure 400 per cent longer or reducing total deformation 50 per cent. Thus small reductions in stress either appreciably increase useful life or decrease total deformation. Also note that 100-hr rupture stress is only 25 per cent above stress for 1 per cent deformation. Thus, while small reductions in stress appreciably improve useful life or deformation of structure, they do not compensate much for inaccuracies in structural analysis (Steinbacher-Young).

The conventional 1.5 safety factor applied to the stress is almost ridiculous under the conditions shown in Fig. 21 since it is considerably more than enough to insure "indefinite" creep life. Applying a safety factor to the temperature is equally ridiculous because even small factors can reduce the stress level as much as, or more than, the conventional 1.5 safety factor used at room temperatures.

Since the safety factor is so intimately associated with weight, a co-ordinated effort between industry, the military, and the CAA is needed to study this problem with the aim of establishing a practical and standardized safety criterion for elevated temperatures that will remain applicable even after new types of high-temperature material are developed.

Conclusions. Until recently, structural research has always been sufficiently ahead of the needs of design to prevent serious delays in the development of aircraft. The opinion is already held that research is today merely sweeping up after the designers.

The magnitude of the thermal problem is such that over-all research, unless accelerated, will soon find itself five to ten years behind aerodynamics and propulsion. To correct this, a co-ordinated study of the whole high-temperature field is needed. Nibbling away at the fringe problems associated with 300-F temperatures is entirely inadequate; investigation of the problems peculiar to each temperature range up to 1000 F, and even beyond, is required.

Liquid-Metal-Cooled Reactors

By C. R. Stahl

Knolls Atomic Power Laboratory,[1] Schenectady, N. Y.

The mechanical design of liquid-metal nuclear reactors is fundamentally no different from any other design project. The general design criteria apply to this area of work as they do to any other. However, certain problems are emphasized to such a point that they seem to be new and strange. The author analyzes some of these problems and reduces them to practicable dimensions for the designer to follow. A stage has now been reached where the reactor is no longer a mysterious "black box" but a project to be developed by normal engineering principles.

Because of unusual emphasis on certain facets of the design of liquid-metal-cooled nuclear reactors and our lack of experience in this field, it has been necessary in the work done up to this time to approach all the design problems from a fundamental analytical and experimental viewpoint.

A factor in reactor design that differs from most normal designs is that of radioactivity. This factor is related to the difficulty of obtaining complete reactor-system tests. These tests would involve the reactor and its heat-exchange system. The cost of such an installation, together with the difficulty of making modifications to the reactor after it has operated, make such a program undesirable unless the system has a very good chance for success. The difficulty of working on a reactor after some full-power operation is tremendous when compared to normal maintenance. The radioactivity of the parts is such that all work must be done remotely with heavy shielding protecting the personnel.

Now, with the completion of the SIR (Submarine Intermediate Reactor) design by the Knolls Atomic Power Laboratory, a much better understanding of the critical design areas is known. This understanding will facilitate future reactor development.

Nuclear Requirements

It is obvious that the nuclear requirements must be met by the reactor designer. His job is to arrive at a satisfactory mechanical design that approaches as closely as practicable those theoretical conditions which cannot be checked experimentally. This is necessary, since the effects of deviation from them is not known accurately. However, with more detailed nuclear information about a specific reactor, the designer has greater freedom in the details of his design. The detailed information about a specific design is obtained experimentally by the use of the zero-power reactor or critical assembly. This is an experimental tool that is nuclearly similar to the reactor being designed. It operates at critical but at a very low, power (a few watts) and, therefore, does not become significantly radioactive.

Because of the nuclear requirements, the designer of a liquid-metal reactor must establish a nuclear quality control and become an "atom watcher." Small changes in density, impurities, and dimensions can affect nuclear characteristics seriously. Such requirements necessitate careful design and equally careful fabrication, for there can be impurities in dirt and grit. The designer must place close mechanical and chemical tolerances on critical parts of the reactor so that the desired nuclear characteristics can be achieved. It also allows prediction of nuclear characteristics for future refuelings so that the optimum nuclear point can be obtained without complicated nuclear adjustments. This means that a new set of parts could be installed into a reactor without having to worry about large nuclear changes. Such a change could then be made by operating personnel rather than highly trained specialists in physics.

To achieve this objective, there is actually a selective assembly of parts so that nuclear variations in these parts offset one another in an assembly. Cleanliness of parts and assemblies to eliminate nuclear as well as chemical contamination is assured by special work areas and protective clothing. To determine the nuclear characteristics of parts, a chemical analysis is made on all material lots, the parts are weighed accurately and, as a final check, the parts are checked in a critical assembly. This information is tabulated and used to insure the proper nuclear characteristics of a completed reactor.

Heat Generation and Flow

The reason for the existence of a power reactor is to generate heat at a useful temperature. Ideally, the outlet temperature should be as high as possible, the reactor size should be as small as possible, and the coolant pressure drop should be as low as possible. These requirements are desired because the reactor is one component part of a heat generation-and-transfer system that includes the reactor, heat exchangers, and pumps. A high reactor outlet temperature and low pumping power help to obtain a high over-all plant efficiency. The reactor size of a mobile plant is important since it must be shielded. The larger it is, the greater the shield weight, size, and cost.

In a liquid-metal system where heat-transfer film coefficient is not a limitation, the heat removal is dependent almost completely upon mass flow. The quantity of heat removal is given by the following equation:

[1] The Knolls Atomic Power Laboratory is operated by the General Electric Company for the Atomic Energy Commission.

Contributed by the Power Division and presented at the Semi-Annual Meeting, Pittsburgh, Pa., June 20–24, 1954, of The American Society of Mechanical Engineers. (Condensed from ASME Paper No. 54—SA-60.)

$$Q = C_p \rho A v \Delta t$$

where

Q = quantity of heat removed from reactor in unit time
C_p = heat capacity of coolant per unit weight per deg F
ρ = weight density of coolant
A = total cross-sectional area of reactor coolant channels
v = coolant velocity
Δt = temperature rise of coolant in passing through reactor

Since the heat capacity and density of coolant are fixed for a certain coolant, the variables the reactor designer has are those of cross-sectional area of coolant passages, coolant velocity, and temperature rise. It becomes obvious that the best method of achieving the desired small size and low pressure drop is to have large temperature rise of the coolant as it passes through the reactor. A single-pass coolant system also is indicated for low pressure drop.

With the establishment of a large temperature rise to satisfy system requirements the reactor designer has several real problems. The most important one is to minimize temperature differences across the structural members of the reactor. These temperature differences can lead to high thermal stresses. Since the heat generation in the reactor core varies with location, the coolant-mass flow in the single-pass system must match the heat generation reasonably well to prevent any excessive temperature differences in this region.

While the cooling for a known heat-generation condition can be established by analysis and flow tests, the problem of cooling a changing heat-generation profile properly is extremely difficult if not impractical. Since the heat-generation profile changes with the burn-up of fuel and control-element positions, it becomes evident that the orificing of a coolant cannot match closely the heat generation under all conditions. This means that large temperature differences can exist at the core exit if large changes in heat distribution occur. Fig. 1 gives an example of how heat-generation gradients might look for two conditions of the SIR reactor.

The cause of the change between heat-generation profile given by conditions (1) and (2), Fig. 1, is the insertion of a control element at the core interface. In the first condition the reflector region causes neutrons to return into the core where they cause fission of the fuel at this place. The heat generation is proportional to the number of fissions that occur, and the number of fissions is a function of the neutron density, the number of fuel atoms present, and the energy of the neutrons. Since in most reactors the fuel loading does not vary with location, the neutron density and energy are the primary factors which cause power-generation changes with control-element position. In the first case the control element is not present; therefore the neutron flux is normal in the core with an additional component from the reflected neutrons. The reflected neutrons are of low energy and most of them have a velocity corresponding to the temperature of the surroundings; hence they are called "thermal" neutrons. Since thermal neutrons are more easily absorbed by the fuel than those with higher energies, the neutrons returned from the reflector cause fissions only in the outside edge of the core. This produces the sharp heat-generation gradient in this region.

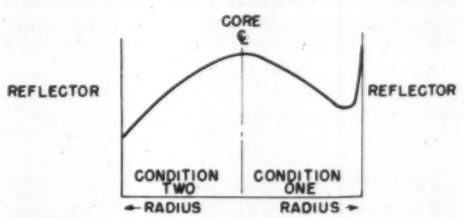


Fig. 1 Heat-generation gradients for two conditions of SIR reactor

In condition (2) a control element which is made from neutron-absorbing material is inserted at the core-reflector interface. This eliminates the neutrons that are returning from the reflector as well as generally lowers the neutron flux in this region; therefore the heat generation is only a portion of what it was in condition (1). This same sort of thing happens when control rods are inserted in the core by lowering the neutron flux in a local region.

In regions outside the core only a small percentage of the total heat is generated. These regions can be cooled by natural circulation of the liquid-metal coolant. This is a desirable and easy way to prevent large temperature gradients during steady state. However, because of the large thermal time constant of this region compared to the core, certain transient conditions can impose temperature gradients of large magnitude between it and the core.

It becomes evident from the foregoing discussion that temperature differences will exist in the coolant in the core and adjacent regions because of mismatching heat generation and flow. The coolant temperatures are reflected in the temperatures in the structures of the reactor, since with a liquid-metal coolant little temperature difference can exist between them.

These temperature differences can be sizable because, as was stated previously, liquid-metal reactors normally have a large temperature rise across them. For example, if the reactor has a 300-deg F temperature rise, a 50 per cent mismatch could allow 150-deg F temperature variation. These temperature gradients then give rise to the thermal-stress problems in a liquid-metal-cooled power reactor.

Another type of temperature differences that can exist in structures is that caused by rapid temperature transients. Since the heat generated by nuclear reactors can be turned on and off rapidly, the coolant temperatures can change just as rapidly, thereby causing rapid temperature changes in structural members. The outer fibers adjacent to the coolant will change temperature while the main portion of the structure will not yet have been affected. These outer fibers then are stressed severely.

Thermal Stresses

Since sizable temperature differences are likely to exist within various structures, the designer must use his ingenuity to minimize the resultant thermal stresses. By a simple analysis it can be seen that with the large temperature rise identified with liquid-metal reactors, sizable stresses can exist. Based on an elastic basis, the use of austenitic stainless steel, and a linear temperature rise of 300 deg F across a thin-walled cylindrical shell, the following stress would occur:

$$S = \frac{E\alpha\Delta t}{2(1-\nu)}$$

where

S = stress, psi
E = Young's modulus (26×10^6), psi
α = coefficient of expansion (10^{-6} in/in/deg F)
ν = Poisson's ratio (0.3)
Δt = temperature rise, deg F

$$S = \frac{26 \times 10^6 \times 10^{-6} \times 300}{2(0.7)}$$

$$S = 55{,}000 \text{ psi}$$

This is considerably above the allowable stress. Hence it is necessary to limit local deviations of temperature in structures to much lower values. The actual stress for the example given would be lower in annealed material and a plastic strain would have taken place.

As with any problem, there are certain general directions the design should take to minimize these problems. The first and most obvious is to make units small or thin so that a temperature difference cannot exist across them. Another is to make the unit flexible. In liquid-metal-reactor design the use of flexibility in structures is an effective means of minimizing thermal stresses However, care should be taken to prevent designs from becoming flimsy and, therefore, subject to failure because of vibration and mechanical shock where such be the requirements.

An example of this is the use of hinged joints to allow rotation at junction points. When a temperature gradient is axially applied to a large-diameter cylinder, this flexibility considerably reduces the stresses. This can be shown by Fig. 2. With a temperature gradient as indicated in (1) the cylinder would take a position as shown in (2) and the end pieces would be a diameter corresponding to their average temperatures. With rigid attachment a bending moment is applied at the junction point. This gives rise to the stresses; however, with a flexible joint as shown in (3), these are eliminated.

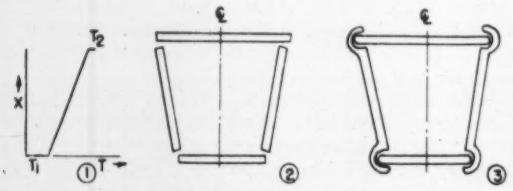


Fig. 2 Temperature gradient applied axially to large-diameter cylinder

It can be seen that the ends on the cylinder give a restraint when no flexibility is allowed. With a steep temperature gradient this bending stress can be quite large. The flexibility of the ends will relieve these stresses.

Another method of minimizing thermal stress is to use baffles. These baffles are members that have some flexibility and act as insulation to protect structural members. By use of such members a conduction gradient can be obtained and the temperature gradient effectively reduced. This is shown in Fig. 3.

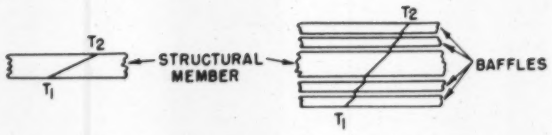


Fig. 3 Method of minimizing thermal stress by using baffles

When the temperature gradient is taken across the laminated structure the average temperature of the pieces is different and, therefore, there is movement between the laminations. Each lamination takes the temperature drop that is proportional to its thickness. The baffle thickness and the number of baffles can be adjusted so that not only steady-state temperature differences can be accommodated but also rapid transients. A rapid change in coolant temperature also will cause a transient-temperature gradient in a structural piece. These baffles protect against excessive stresses because of these transients.

By using the foregoing design principles the designer in almost all cases can reduce the thermal stresses to a value where they are no longer a problem.

Mechanism Problems

Since most reactors require mechanism for their control, a problem common to all are mechanisms operating reliably in high-temperature regions, in the coolant, and in radiation regions. These mechanisms must be highly reliable, particularly those in the high-temperature and radioactive regions.

With a liquid-metal system the designer has several conditions to factor into his design. Since the mechanism usually must provide a gas-and-liquid-metal seal, he can use the properties of the liquid metal for this. For certain applications he can allow the coolant to freeze and effectively make its own solder joint. Such a joint is effective because the pressure against which it is sealed can be low (less than 100 psi). This solder joint also can become a hazard if it binds a shaft so it cannot be actuated.

In so far as mechanisms are concerned, bearings offer another problem. All mechanisms have bearings of some sort, and the reactor designer's objective is to reduce bearing loads to an absolute minimum to obtain maximum life and reliability. This reliability is complicated by the fact that the lubrication properties of liquid metals are very poor. These objectives are obviously desired because of the difficulty of replacing bearings in a highly radioactive assembly that makes accessibility and maintenance exceedingly difficult.

Again, by simple and reliable design and emphasis on the different problems, these mechanism difficulties do not differ a great deal from normal practice.

With the review of some of the problems, it can be seen that design solutions do exist and there is really nothing too different about the design of liquid metal-cooled reactors. The major difficulty, that of lack of experience, has been overcome partially by experience on the SIR (Submarine Intermediate Reactor). With this experience, and a thorough analytical and experimental program, the problem of high reliability can be solved effectively. The accessibility problems are basic with nuclear reactors, but by recognizing the reliability and simplicity of design this limitation requires, designs can be made to give adequate accessibility.

Boiling Heat Transfer:

What Is Known About It

By W. H. Jens

Nuclear Development Associates, Inc.
White Plains, N. Y.

Recently, a great deal of attention and effort have been directed toward obtaining a better understanding of boiling heat transfer. This recent emphasis has been motivated by the need to cool rockets, jet engines, and nuclear reactors. The importance of the subject is indicated by the estimated expenditure of approximately $3 million for boiling research during the past ten years. This paper attempts to answer these questions regarding so large an expenditure:

- Why is such a large research effort necessary?
- Why is it so expensive to obtain fundamental boiling data?
- What progress has been made in the study of boiling?

• Why Is Boiling Research Necessary?

In cooling a high-performance machine such as a rocket, jet engine, or nuclear reactor we are dealing with comparatively small volumes in which are generated tremendous quantities of heat. For example, the average heat generated per unit volume in a modern boiler is 10^4 Btu/ft^3 hr, whereas in a jet engine the heat generated is 10^7 Btu/ft^3 hr. In a rocket and in a nuclear reactor it might be as great as 10^9 Btu/ft^3 hr. One method of removing this heat or of cooling the confining structure is by utilizing boiling with its high heat-transfer rates and almost constant heat-transfer surface temperatures. Heat fluxes as high as 10,000,000 Btu/ft^2 hr have been obtained experimentally, and practical designs are possible with heat fluxes as great as 2,000,000 Btu/ft^2 hr. These heat fluxes can be contrasted to the heat flux in a modern boiler of about 100,000 Btu/ft^2 hr. Both applications use boiling heat transfer but of different types.

It is the characteristic of nuclear reactors and, to a large extent, of jet engines and rockets that they are constant heat-input systems. That is, regardless of the cooling rate a constant quantity of heat is generated, and if the cooling is inadequate the surface transferring heat will fail either by melting or possibly by very rapid corrosion due to its high temperature. If the cooling were to have been stopped in the experimental apparatus transferring heat at 10,000,000 Btu/ft^2 hr the surface would have melted in a fraction of a second.

The cost of reactors, jet engines, and rockets may run as high as several millions of dollars, and although nuclear reactors and jet engines are not inherently unsafe a coolant failure could be very serious in terms of human life. These then are the immediate and obvious reasons why a great deal more must be known about boiling heat transfer.

• Why Is This Research So Expensive?

Boiling heat transfer involves a change in phase from liquid to vapor. Where the viscosity, density, thermal conductivity, and specific heat of the fluid could be used to describe single-phase heat transfer, in boiling many additional properties are required. The surface tension, latent heat of vaporization, saturation temperature, density of vapor, and possible other properties of both the liquid and the vapor must now be considered. In addition to the physical properties of the vapor and liquid, the geometry and mass flow, which are known to affect single-phase heat transfer, must also be considered here. Also the character of the surface transferring heat, such as the type of metal, the roughness, and the adsorbed gas seem, under certain conditions, to affect the boiling heat-transfer results. In general, because of the large number of variables, a separate investigation is required for each combination of fluid and surface. When the conditions are unusual or extreme, which they are in many cases, the cost of the investigation is great. The time is near, however, when these separate investigations will no longer be necessary.

In most boiling investigations the determination of the heat-transfer coefficient is a small fraction of the entire amount of information required. Other items such as the maximum heat that can be transferred by the surface without overheating, the pressure drop, the stability of the boiling, the density of the fluid, and other related effects are of greater importance.

In summary, research in this field is expensive because of the complexity of the problem and the need for a wide variety of associated information.

• What Is the Status of Boiling Research?

The morass of terminology used to describe boiling is

Based on a paper contributed by the Applied Mechanics and Heat Transfer Divisions and presented at a meeting of the Metropolitan Section of The American Society of Mechanical Engineers, New York, N. Y., April 7, 1954.

probably very confusing. Terms like nucleate, incipient, local, pool, film, pot, bulk, saturated, subcooled, net, forced convection are prefixes that have been attached to boiling. Many have overlapping meanings, and probably no one will agree completely to all of the meanings. In order to illustrate the various types of boiling, consider heating water in a pan on the stove. As the water is heated small gas bubbles will first form at the surface. These bubbles form because of a decrease in solubility of the gas in water with a rise in temperature. Shortly thereafter very small bubbles appear that rapidly grow and collapse at the heated surface. This is called nucleate boiling because the vapor bubbles start their growth on localized ridges or valleys in the heat-transfer surface, around small dirt particles, or around groups of gas molecules all being possible nuclei for the initiation of a bubble. The bubbles grow because the water next to the heat surface is above the saturation temperature. As the bubbles extend into water, which may be below the saturation temperature, they collapse. This type of boiling is called local boiling or subcooled boiling. When the bulk of the water is heated to its saturation temperature, bubbles detach from the heated surface and continue to grow in the bulk of the fluid. The bubbles are much larger, in many cases being merely masses of vapor. This type of boiling is called saturated, pool, pot, or net boiling. If the water had been stirred either when the temperature was below or at saturation temperature, forced-convection boiling would have been obtained. Consider now that the pan had boiled dry and that a small amount of water was then added to the hot pan. In this case drops of water would dance on the surface, being insulated from the surface by a film of vapor. This is called film boiling and is characterized by the film of vapor between the water and the heated surface.

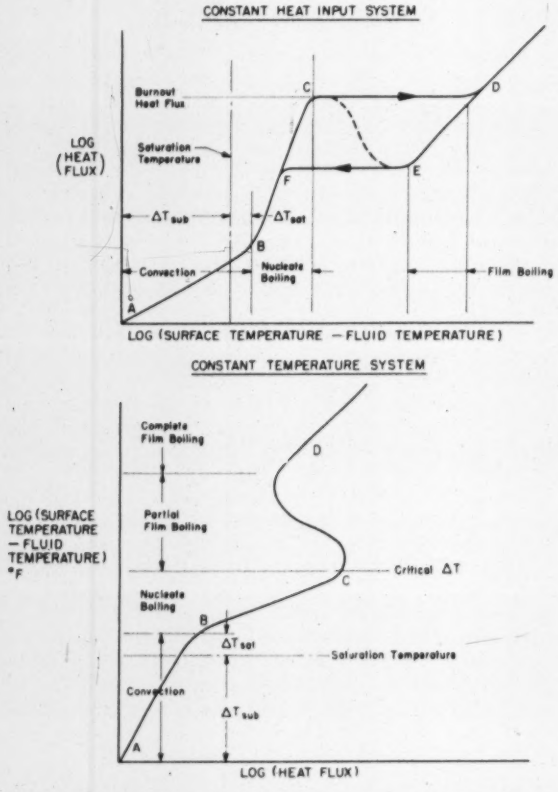


Fig. 1 Major difference between constant heat input and constant surface-temperature systems

Nomenclature

C_l = Specific heat of liquid, Btu/lb deg F
g = Acceleration of gravity
g_0 = Conversion factor, 4.17×10^8 (lb mass) ft/hr² (lb force)
G = Mass flow rate, lb/ft² hr
h_{fg} = Latent heat of vaporization, Btu/lb
m, C, C_{sc} = Constants
P = Pressure, psia
q'' = Heat flux, Btu/ft² hr
$q''_{B.O.}$ = Maximum or burnout heat flux, Btu/ft² hr
$q''_{conv.}$ = Heat flux by convection at fluid velocity, temperature and pressure Btu/ft² hr
V = Velocity, fps
Pr_l = Prandtl number
ρ_l = Density of saturated liquid, lb/ft³
ρ_g = Density of saturated vapor, lb/ft³
ΔT_{sub} = Temperature difference between the saturation temperature and the fluid temperature, deg F
ΔT_{sat} = Temperature difference between the surface temperature and the saturation temperature, deg F
μ_l = Viscosity of saturated liquid, lb/ft hr

Another method of classifying boiling information is by the type of heating used. The two classifications are the constant heat input and the constant surface-temperature system. The information required or obtained and the importance of the individual variables are considerably different for each case. Fig. 1 illustrates a major difference between the two systems and shows the variation of surface temperature with heat flux, which is the amount of heat flowing per unit of surface area per unit of time, for (*a*) a constant-heat-input system typified by a nuclear reactor and (*b*) a constant-temperature system typified by a heat exchanger in which heat is transferred from a liquid metal to boiling water. The curves are probably representative of forced convection, subcooled boiling, in which the fluid is below its saturation temperature at the heat-transfer surface and is being forced to flow past the surface. This relationship has not been completely experimentally verified. The curves are similar for boiling of a fluid at its saturation temperature and for boiling in which the flow is by natural instead of forced convection. This has been verified by experiment.

Except in the region of partial film boiling the two curves in Fig. 1 are identical, one being a mirror image of the other and rotated 90 deg. The reason the curves are drawn separately is to show the effect of a change in the independent variable. In both cases the independent variable is plotted on the ordinate and the dependent variable on the abscissa. In the case of the constant-heat-input system the independent variable is the heat flux whereas in the constant-temperature system it is the temperature difference.

Both curves are drawn for a constant pressure and constant bulk fluid temperature. At values of the surface or wall temperature below the fluid saturation temperature, heat is transferred by convection and is proportional to the temperature difference between the

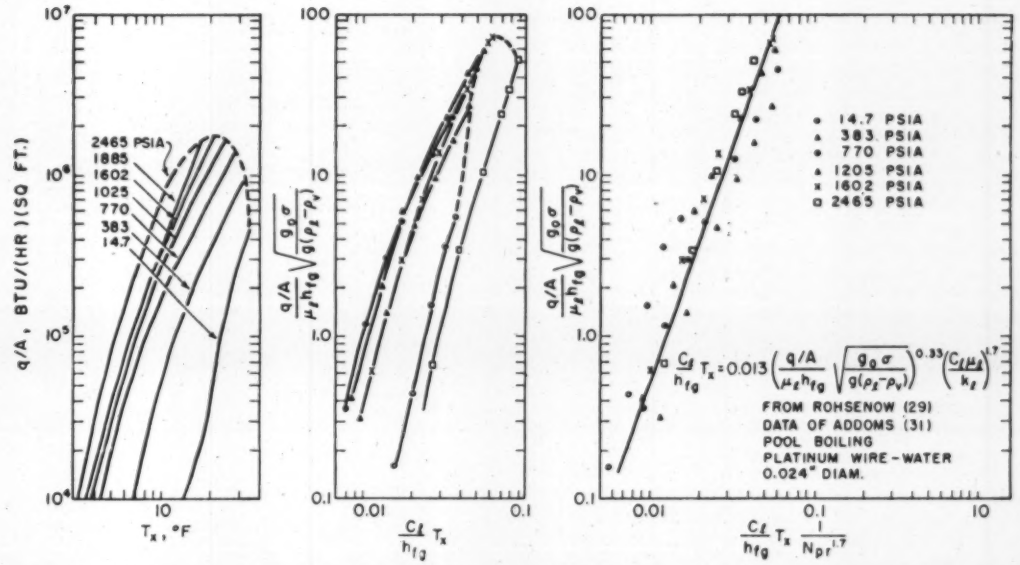


Fig. 2 How the Rohsenow formula was applied to correlate data of Addoms for pool boiling on platinum wire in water (ref. 11)

surface and the fluid. This is region AB. After the surface exceeds the saturation temperature of the fluid the heat flux rises rapidly with an accompanying small change in surface temperature. This region of nucleate boiling is designated as BC. Small vapor bubbles form rapidly due to the superheating of the surface and fluid adjacent to the surface. As they extend themselves into the subcooled or cooler fluid beyond the superheated film they quickly collapse.

In the case of a constant-temperature system as given by the lower curve, when the critical ΔT is exceeded, the heat-transfer rate decreases with increasing surface temperature. In this region there is probably a combination of two types of boiling. On part of the surface small bubbles still form and collapse and on another part of the surface, layers of vapor exist due perhaps to a lack of wetting or to the coalescence of the small bubbles. This layer of vapor effectively insulates the surface, thereby reducing to a small fraction the heat being transferred in the nucleate boiling region. This is region CD. Finally at point D the entire surface is covered by this thin layer of vapor through which heat is transferred by conduction and radiation. As the surface temperature is increased more heat is transferred. This is indicated by the curve beyond point D.

In the constant-heat-input system if the maximum heat flux is exceeded the corresponding temperature in the film-boiling region is great. In many cases, particularly for subcooled boiling, the surface temperature at D exceeds the melting point of the metal, and the surface is destroyed. As mentioned previously, melting might occur in a fraction of a second. If, however, the surface temperature in the film-boiling region does not exceed the melting point of the surface, then the region of film boiling behaves as previously described for the constant-temperature system. When the heat flux is reduced below the minimum point shown on the curve at point E, the surface temperature decreases to the value in the nucleate boiling region at the same heat flux, shown at point F. For a constant heat-input system the partial film-boiling region is unstable and therefore is difficult to determine.

Boiling Heat-Transfer Correlations

Numerous experiments have shown that boiling heat transfer as indicated by these two curves is not significantly dependent on the fluid velocity or the temperature of the fluid but does depend on pressure and the difference in temperature between the surface and the saturation temperature.

Surface temperatures have been correlated to ±15 F over a wide range of conditions in a constant-heat-input system with nucleate boiling. Table 1 shows a few of

Table 1 Boiling Heat-Transfer Correlations

Formula	Source	Range of Variables
$\Delta T_{sat} = C\,q''^{0.26}$	McAdams	Subcooled water 60 to 90 psia 5 to 20 fps
$\Delta T_{sat} = 28 - 0.012P$	Rohsenow	Subcooled water 1000 to 2000 psia 10 to 30 fps
$\Delta T_{sat} = \frac{60\left(\frac{q''}{10^6}\right)^{1/4}}{e^{\frac{P}{900}}}$	Jens and Lottes	Subcooled water 85 to 2500 psia 3 to 40 fps
$\frac{c_\ell \Delta T_{sat}}{h_{fg}} = C_{SF}\left[\frac{q_B''}{\mu_\ell h_{fg}}\sqrt{\frac{g_0}{g(\rho_\ell-\rho_V)}}\right]^{0.33} Pr_\ell^{1.7}$ $q_B'' = q'' - q''_{conv}$	Rohsenow	Saturated pool boiling Subcooled boiling Variety of fluids 14.7 to 2000 psi 0 to 40 fps

these relationships. The surface temperature is normally correlated by ΔT_{sat}, as indicated by the difference in temperature between the surface and saturation temperature. ΔT_{sat} varies as the $^1/_3$ or $^1/_4$ power of the heat flux. At 2000 psi, for example, where ΔT_{sat} is about 5 to 6 F, the heat flux can be increased by about a factor of 10 with an increase of only 6 F in the surface temperature. The third formula indicates the pressure effect. At atmospheric pressure ΔT_{sat} is approximately 40 F and the surface temperature is 212 + 40 or 252 F, whereas at 2000 psia, ΔT_{sat} is 6 F and the surface temperature is 642 F. The final formula is the most general. Using dimensional analysis, Rohsenow arrived at a dimensionless correlation for boiling. He defined the conventional Reynolds number in terms of the bubble diameter and frequency, the Nusselt number in terms of the bubble diameter and heat flux, and the Prandtl number in terms of the properties of the liquid. When the formula is applied to forced convection subcooled boiling a quantity termed the boiling heat flux is used. The boiling heat flux is defined as the difference between the total heat flux and the heat flux that could be transferred by convection if boiling had not occurred. Fig. 2 shows how the formula was applied to correlate the data of Addoms. In the first curve the bubble Reynolds number is plotted versus the bubble Nusselt number. It is not until the liquid Prandtl number is used that the data are correlated as shown in the last set of curves.

Rohsenow indicates that many other variables influence nucleate boiling heat transfer. As a matter of fact, he introduces an arbitrary constant to account for different fluid and surface combinations. He indicates that probably the most important variable not included in his final dimensionless equation is the average bubble contact angle. Fig. 3 shows the bubble contact angle which is a measure of the degree of wettability of the fluid upon the surface. The contact angle decreases with greater wetting and the heat transfer increases. The increased heat transfer is probably because less surface is directly covered with vapor films and because the turbulence in the film of superheated fluid is greatest with the smaller bubbles since the bubbles probably grow and collapse more rapidly. Some recent work with boiling liquid metals adds a great deal of credence to Rohsenow's postulation. The results are also shown in Fig. 3. Sodium, sodium-potassium, and mercury with additions of 0.02 per cent magnesium and 0.001 per cent titanium indicate the familiar convection and the steep boiling relationship when the heat-transfer coefficient is plotted against the temperature difference. However, mercury, with and without 0.1 per cent sodium added, and cadmium, all of which do not wet the heat-transfer surface, apparently do not undergo nucleate boiling. It appears that a transition is made directly from the forced-convection region into the film-boiling region. These results not only verify Rohsenow's thesis but also indicate a possible mechanism to explain burnout.

In addition to the effect of wetting on boiling heat transfer there are other secondary effects. In very pure systems it is possible to superheat surfaces to very high temperatures. For example, at atmospheric pressure, liquid superheats of 76 F were obtained for pure water contained in a glass system at atmospheric pressure. Maintaining the purity of the water and the cleanliness of the surface is extremely difficult and in practical designs these high superheats are seldom obtained. The surface roughness also affects boiling heat transfer.

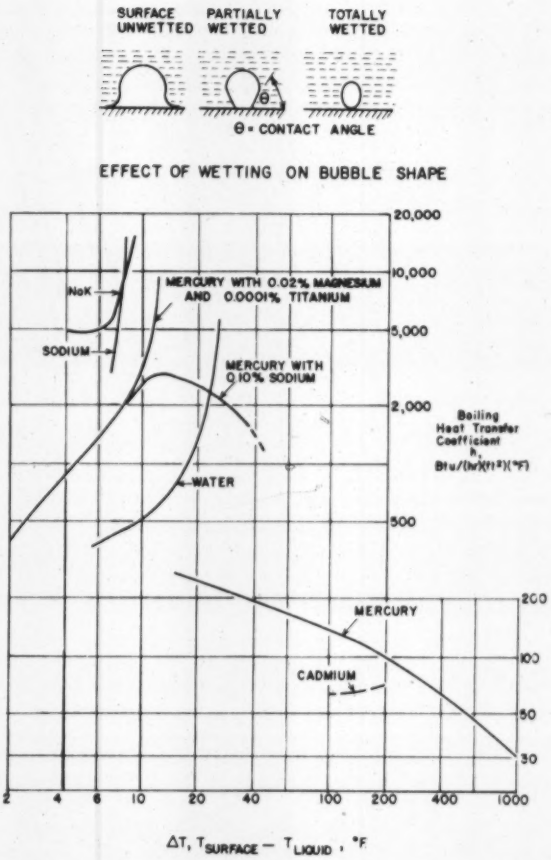


Fig. 3 Comparison of experimental boiling heat-transfer coefficients for water and liquid metals (ref. 2)

The rougher the surface the lower the temperature of the surface during boiling. Both adsorbed gas on a metal surface and dissolved gas in the fluid will initiate boiling at a lower surface temperature. As the gas is removed from the system the surface temperature will increase. The characteristic size of the surface such as a heated-wire diameter does not become important unless the size is of the same order of magnitude as a bubble.

Burnout

As mentioned previously the peak heat flux in a constant-heat-input system is most important data. In saturated pool boiling if the maximum heat flux is exceeded the surface temperature will increase to a higher temperature. In many cases, depending on the material, the surface will not melt or fail but will continue to operate at this high temperature. The prediction of this heat flux is believed to be quite reliable. Fig. 4 shows a correlation of data for these conditions. In addition to the data shown on the slide, several other investigators have obtained data for water which agree very well with the organic fluids used in the investigation shown in Fig. 4. The data were correlated as a function of the maximum heat flux divided by the critical pressure versus the ratio of the system pressure to the critical pressure. It should be noted that an additional

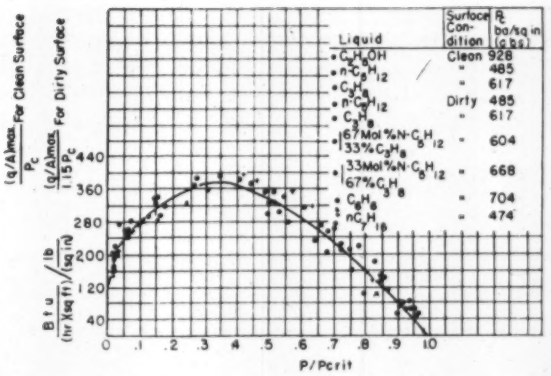


Fig. 4 Correlation of data for condition of peak heat flux or burnout (ref. 5)

constant of 1.15 was required to correlate data obtained for surfaces which were dirty. The maximum possible heat flux appears to occur around $^1/_3$ of the critical pressure which in the case of water is about 1000 psi with a heat flux of $1^1/_4 \times 10^6$ Btu/ft² hr. This is about three times greater than the maximum heat flux at atmospheric pressure.

For surface boiling with forced circulation the attainable heat fluxes are much higher than with pool boiling. A great deal of the research effort has been directed toward obtaining an understanding of burnout in this region. In most all cases the experimental data were obtained in a long heated tube. The tube generally burned out or started to overheat at the outlet end. The data reported were for the local calculated conditions at the exit of the tube where overheating started to occur. The resulting correlations are shown in Table 1. In the last correlation both the constant C and exponent m were found to be functions of pressure. Apparently only two variables appreciably affect burnout. The maximum heat flux varies approximately as the $^1/_2$ power of the velocity and with the 0.2 to 1.0 power of ΔT_{sub}. Except for this agreement the correlations are not too consistent or reliable. Due to the simultaneous occurrence of an increase in pressure drop at the outlet section of the heated tube, together with the critical conditions of flow, fluid temperature, and heat flux, that have been called burnout, a satisfactory correlation is difficult to obtain. If the increase in pressure drop is sufficiently large compared to the over-all system pressure drop the flow in the tube tends to decrease. Since the heat input is obtained by electric-resistance heating it remains practically constant and the temperature of the fluid at the outlet end of the heated tube increases, resulting in conditions more critical than before. The pressure drop continues to increase and the flow continues to decrease until the heated tube is void of liquid and it overheats and burns out.

This autocatalytic effect has a greater tendency to occur in experimental systems which use a centrifugal pump and in which a large part of the total available pressure drop occurs along the heated tube. In many cases the flow instrumentation does not have a sufficiently fast response to detect a sudden decrease in flow at burnout. The flow before the autocatalytic event occurs is usually the recorded flow.

In systems in which a special effort is made to insure positive flow, the data become more predictable and reproducible. Higher heat fluxes are then obtained for the same flow rate and temperature at the inlet of the heated tube.

Many of the applications of nucleate boiling are in systems in which pressure drop remains constant, such as in heated parallel-flow channels. Without knowledge of the pressure drop the data obtained in a constant-flow system are not generally applicable. For this reason and because of the seriousness of a burnout prediction, the data and correlations shown in Table 2 should be used with caution. The correlations are most reliable at the higher subcoolings because of the smaller increase in pressure drop at burnout.

Burnout for Net Boiling

A considerable number of experimental data indicated that heat fluxes as high as 3,000,000 Btu/hr ft² were obtained with calculated exit-steam qualities of 30 per cent (i.e., 30 per cent of the water by weight was vaporized at the heat-transfer surface). It was only with a great deal of difficulty that these data were obtained because of the high pressure drops that were developed. In a practical system it is normally not possible to attain these high fluxes. However, at reasonable fluxes and pressure drops, fluids that wet the heat-transfer surface can be vaporized to 80 per cent by weight without any large change in heat-transfer rates, if the surface transferring the heat is vertical and the heated passage has an L/D greater than 50. In the case of horizontal tubes or surfaces, flow separation might occur at very low qualities and the upper portion of the surface would overheat. Horizontal heat-transfer surfaces tend to overheat at the point where steam is first formed, since this is the point of lowest velocity and therefore the greatest possibility of steam separation.

Fig. 5 indicates the effect of length-to-diameter ratio for a vertically heated passage. As the length to diameter of the passage is decreased the exit quality at which overheating occurs decreases. In very short tubes the central core of liquid in the tube passes the heat-transfer

Table 2 Forced-Convection Burnout Correlations

Formula	Source	Range of Variables
$q''_{B.O.} = (400{,}000 + 4800\,\Delta T_{sub})V^{1/3}$	McAdams	V from 1 to 20 fps P from 30 to 90 psia ΔT_{sub} from 20 to 100 F
$q''_{B.O.} = 7000\,V^{1/3}\,\Delta T_{sub}$	Gunther	V from 5 to 40 fps P from 14 to 160 psia ΔT_{sub} from 20 to 280 F
$q''_{B.O.} = 520\,G^{1/3}\,\Delta T_{sub}^{0.2}$	Buchberg	V from 5 to 30 fps P from 500 to 2000 psia ΔT_{sub} from 3 to 160 F
$q''_{B.O.} = C\left(\frac{G}{10^6}\right)^m \Delta T_{sub}^{0.22}$	Jens and Lottes	

P, psia	m	C
500	0.16	0.817
1000	0.28	0.626
2000	0.50	0.445

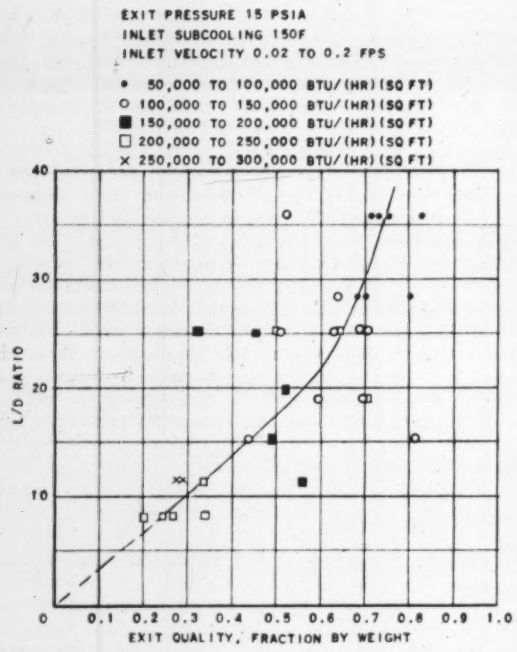

EXIT PRESSURE 15 PSIA
INLET SUBCOOLING 150F
INLET VELOCITY 0.02 TO 0.2 FPS
• 50,000 TO 100,000 BTU/(HR)(SQ FT)
○ 100,000 TO 150,000 BTU/(HR)(SQ FT)
■ 150,000 TO 200,000 BTU/(HR)(SQ FT)
□ 200,000 TO 250,000 BTU/(HR)(SQ FT)
× 250,000 TO 300,000 BTU/(HR)(SQ FT)
L/D RATIO
EXIT QUALITY, FRACTION BY WEIGHT

Fig. 5 Effect of length-to-diameter ratio for a vertically heated passage (ref. 3)

surface before it can be mixed in order to come in contact with the surface and be vaporized. Therefore a considerable fraction of the fluid cannot be vaporized and the tube overheats at relatively low qualities.

Boiling and Burnout With Two Components

Another item of significance in the utilization of boiling heat transfer is the boiling of a mixture of components, which are either miscible or immiscible. It is possible that burnout might be prevented by the addition of another fluid which has a slightly higher saturation temperature. Fig. 6 shows the heat-transfer behavior of a mixture of hydrocarbon fuels. The familiar increase in heat transfer is indicated when the surface temperature exceeds a prescribed amount. However, as the maximum heat flux is exceeded, the temperature of the surface appears to increase only to a value associated with the original heat-transfer coefficient. This temperature will probably not cause failure but might be used as a shutoff warning.

Summary

The status of boiling research can be summed up as having passed through a first stage, in which a great deal of emphasis was placed on determining the effect of the properties of the fluid, and surfaces on boiling heat transfer, and the maximum heat flux. The more subtle effects such as pressure drop, effect of wetting, and changes in density are presently being emphasized as the second phase of boiling research.

References

1 "Heat-Transfer Studies Relating to Rocket Power-Plant Development," by L. G. Dunn, W. B. Powell, and H. S. Seifert, Third Anglo-American Aeronautical Conference, 1951, published by the Royal Aeronautical Society.

2 "Boiling Heat Transfer With Liquid Metals," by R. E. Lyon, A. S. Foust, and D. L. Katz, Heat Transfer Symposium, AIChE, December, 1953.

3 "Two-Phase Pressure Drop and Burnout Using Water Flowing in Round and Rectangular Channels," by W. H. Jens and P. A. Lottes, ANL-4915, Oct. 1, 1952.

4 "Analysis of Heat Transfer Burnout Pressure Drop and Density Data for High Pressure Water," by W. H. Jens and P. A. Lottes, ANL-4627, May 1, 1951.

5 "Heat Transfer to Liquids Boiling Under Pressure," by M. T. Cichelli and C. F. Bonilla, Trans. AIChE, vol. 41, 1945, pp. 755–787.

6 "A Method of Correlating Heat-Transfer Data for Surface Boiling of Liquids," by W. M. Rohsenow, Trans. ASME, 1952, p. 969.

7 "Heat Transfer at High Rates to Water Boiling Outside Cylinders," by J. N. Addoms, DSc thesis, Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass., 1948.

8 "Heat Transfer to Water at High Flux Densities With and Without Surface Boiling," by F. Kreith and M. J. Summerfield, Trans. ASME, vol. 71, 1949, pp. 805–815.

9 "Photographic Study of Surface-Boiling Heat Transfer to Water With Forced Convection," by F. C. Gunther, Trans. ASME, vol. 73, 1951, pp. 115–123.

10 "Heat Transfer, Pressure Drop, and Burnout Studies With and Without Surface Boiling for Deaerated and Gassed Water at Elevated Pressures in a Forced Flow System," by H. Buchberg, et al., Heat Transfer and Fluid Mechanics Institute, 1951, Stanford University Press, Stanford, Calif.

11 "Heat Transfer With Evaporation," by W. M. Rohsenow, Heat Transfer—A Symposium, University of Michigan, 1952.

NOTE: A more complete bibliography may be found in references 1, 10, and 11.

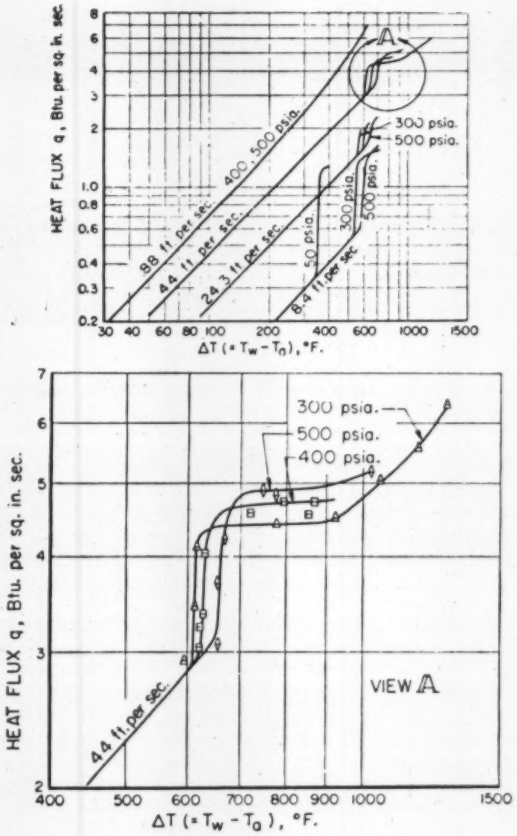


Fig. 6 Heat-transfer behavior of a mixture of hydrocarbon fuels (ref. 1)

Physics . . .

Mother of Instrumentation

By Gaylord P. Harnwell

President of the University of Pennsylvania, Philadelphia, Pa.

Webster's Dictionary defines an instrument very broadly as a "means by which any work is performed." This essentially divides all devices into those which provide the necessary energy for the performance of work and those with which the work is performed. This is a very broad definition of instruments and reminiscent of the statement by the great mathematician, Leopold Kronecker, that "God made the integers and all the rest is the work of man," which might be paraphrased by saying, "God made the sources of energy or the prime movers and all else consists of man-made instruments."

When interpreted according to Webster or Leopold Kronecker's statement, the subject of instrumentation is too broad to be discussed significantly in this brief presentation. In the following, therefore, I will consider instruments as devices which enable us to make quantitative measurements which may, in some instances, be extended also to affect human or automatic control in technical processes. Within this more limited definition would fall the great majority of the devices which are accepted as instruments in the sense of the Instrument Society, but crowbars, wheels, screws, and dental and surgical instruments would be excluded.

Contributions of Physics

Physics, being the quantitative science which deals with the interchange of energy in its various forms, is that area of basic study which is concerned with all of the phenomena involved in instrumentation and in this sense is appropriately considered the parent of instrument development. Very broadly speaking, physics has made two contributions to the development of human society. The first of these, which may well be the most important but is certainly the least tangible, is the contribution to the development of precision of definition and thought without which habit of thinking scientific and technical advances are not possible.

The second contribution of physics is to the material aspect of society through the provision of those technical aids to human effort which have multiplied the per capita efficiency of men to such an extent as to revolutionize the processes on which society depends.

Instruments are the most representative embodiment of the development of precise definition and thought and are the means whereby we are provided with the quantitative information upon which human or automatic judgments are made. They are also a major component in modern technology and, though properly speaking they are auxiliary or ancillary to the main technical processes of our society, they form an essential component of this technology without which it could not exist in the form in which we know it.

Beginnings of Instrumentation

The history of physics has been the history of human quantitative endeavor and the history of instruments has closely reflected the history of development in physics. The physical sciences all have their genesis in the area known to the ancients as natural philosophy, and the beginnings of our simple quantitative concepts in this area are reflected by the instruments whose genesis is shrouded in prehistoric antiquity.

We know that the inhabitants of the valleys of the Nile and the Tigris and Euphrates had devices for measuring the ratios of lengths which provide the measurement of angles, and also devices for measuring the fundamental quantities of length, mass, and time. In ancient Egypt and Babylonia, measuring rods, sundials, and beam balances were to be found, as were instruments for surveying and for the measurement of celestial as well as terrestrial angles. These are the earliest instruments of which we have any knowledge and are the earliest products of physical science and its application to the practical needs as well as to the satisfaction of the natural curiosity of men. It is idle to speculate as to the basic understanding by these ancient peoples of the principles which they were employing, because by the test of practical utilization they were entirely successful within the very generous latitude of precision which must be accorded them.

The development of instruments of this type, as well as those which were evolved in subsequent centuries, has been conditioned not only by our scientific curiosity and our imaginative attempts at its satisfaction, but

Presented at a joint luncheon of the Instruments and Regulators Division of The American Society of Mechanical Engineers, the Instruments and Measurements Committee of the American Institute of Electrical Engineers, and the American Institute of Physics, September 16, during the First International Instrument Congress and Exposition, Philadelphia, Pa., September 13–24, 1954

also by the level of current technology and our ability to accomplish the degree of precision for which we have striven.

Phase of Classical Development

As physics became differentiated from the rest of natural philosophy, it passed through a phase of classical development extending nearly to the beginning of the present century, during which it was characterized by certain well-recognized subdivisions such as mechanics, electricity, heat, sound, light, and the properties of matter. The earliest developments and observations which led to the differentiation of these subdivisions and the definition of the subject matter within them have all been related to the development of the instruments that have characterized these divisions. The principles upon which these have operated are the fundamental principles distinguishing that area of physics, and it is almost impossible to separate the development of science and the development of the instruments and techniques which have accompanied it.

Intellectual speculation is sterile except when it is based upon the facts of observation, and it is these facts which have been supplied first by the early instruments that were developed, and later by their successive refinements as they have been brought about by technical development and by the cross-fertilization between scientific disciplines.

Basic Instruments of Mechanics

In mechanics, the three types of instruments for measuring length, mass, and time, each represents fascinating and instructive courses of development from the earliest forms to our present most precise methods, and each provides examples of the trend in physics toward unification in concept and co-operative progress between areas which in classical times appeared to have little or no relationship.

The history of the standards of length and their intercomparison involves the properties of matter in the establishment of constant standards and optics in methods of comparison; the same is true of standards of mass. The methods of measuring time, which provide possibly the most fascinating historical study of the three, have progressed through the early exemplifications of the sundial and clepsydra to our modern precise standards and the common timepieces in everyone's home or pocket which are instruments of high precision involving either the pendulum or the escapement.

In each of these three instances a further development is probably immediately ahead, based upon the unification of physics represented by the quantum theory of atoms and molecules. The most precise standard of time will undoubtedly shortly be that based upon the fundamental atomic or molecular frequencies. The standard of length will be derived from these frequencies and the invariable velocity of light, and the standard of mass will likely be the most convenient of the fundamental atomic particles.

This brief glimpse of the instruments associated with the most fundamental of physical measurements must suffice as an indication of the historical interest and development of such devices. Gradually, instrumentation has, of course, spread far beyond that applicable to such basic areas, and in mechanics alone, one has a proliferation of instrument types dealing with ratios of these entities, namely, instruments for measuring velocity, acceleration, pressures, densities, and so forth, under all types of conditions and all ranges of magnitudes of these entities.

In the Fields of Heat and Light

Principles of instrumentation exploited during the seventeenth and eighteenth centuries were associated with those fields of physics which were themselves developing during that period, namely, the fields of heat and light. The primary measurement in the field of heat is that of temperature, and thermometers were extensively developed and perfected during this period. Of still greater general interest and applicability, however, was the development of instruments based upon the principles of geometric optics, such as microscopes and telescopes; these made their appearance during this era and were employed in astronomy and biology as well as in the physical sciences themselves.

The most prominent instrumental principles associated with the nineteenth century are those that evolved from the experiments leading to the several theories of light and to our present formulation of the laws of electricity and electromagnetism. The interferometer and its many variants have provided one of the simplest and most precise bases for instrumental techniques. The d'Arsonval, or moving-coil galvanometer, which supplanted the moving-magnet galvanometer, has furnished probably the most widely used instrumental principle to have emerged from the developments of the preceding century. Though early experiments in electricity were concerned rather with electrostatic instruments and moving-magnet galvanometers, the great advantages associated with the moving-coil instruments have made these basic in the field of electrical measurements, and largely through the versatility of this device electrical measurements now share with mechanical measurements the position of greatest fundamental influence in the field of instrumentation in our own day.

It is of some interest that the various devices which we have reviewed briefly are concerned directly with the measurement of thermal expansion, electromagnetic-wave properties, electromagnetic forces, and so forth, rather than with some of the central concepts of physics which have characterized the formulation of this science during the nineteenth century. Momentum, angular momentum, and energy are concepts which have come to assume a central importance, but they are highly derivative concepts not naturally related to direct instrumental measurement. Among common instruments the only one directly measuring work or energy is, for instance, the integrating wattmeter. This is suggestive of the extent to which, in the integration of the various fields of physics, scientific theory has been forced to a formulation in terms of concepts relatively remote from direct observation.

Concepts of the Present Century

The development of instrumentation characteristic of the present century has again been closely related to the enormous technical and ideological developments in physics itself. The work of physics has been concerned with the description of physical phenomena in terms of

atomic, and molecular, and nuclear concepts, and the discovery of the electron had probably as much influence on the direction of instrumental development as the discoveries by Ampere, Henry, and Faraday of electromagnetic forces. Electronics is possibly more a descriptive cognomen for a field of instrumentation than it is for a field of technology. The large range of power amplification, the speed of response, and convenience of the auxiliary components have combined in electronics to bring about a revolution in the older methods of instrumentation and to open up additional fields of application heretofore unavailable.

Electronic instrumentation has made possible the practical exploitation of the discoveries of nuclear physics. For the availability of nuclear explosives as well as nuclear power we are dependent upon the instrumental developments in electronics which characterized the preceding quarter of a century. While the utilization of free thermo or photoelectrons is commonly considered the basis of electronic techniques, this might well be expanded to include conduction phenomena in solids, liquids, and gases. Indeed, gaseous electronics is already a well-recognized subdivision of electronic instrumentation, and the thermistor and transistor and crystal rectifier are rapidly serving as central developments about which the next phase of electronic instrumentation is nucleating.

Advance of Atomic Physics

It is interesting to note that the progress of atomic physics during the first half of this century was characterized first by research in gas conduction, secondly by research in solid conduction, and that the development of atomic theory applicable to phenomena in these areas has been extensive and successful. Our theory of liquids has lagged behind our theory of gases and solids, but it is likely that intrinsically we have an equal interest in conduction phenomena in liquids, and that an expanded research program in this area may not only extend our knowledge of liquids but enable us to utilize them effectively in the area of electronic techniques with particular regard to their unique mechanical properties. This would enable us to extend very fundamentally and significantly the basis upon which electronic instrumentation rests.

The Regeneration Principle

The growth of instrumentation and the provision of precise information upon which human actions and control can be based is a fascinating story of scientific and technical accomplishment. However, the incorporation of the principle of regeneration, permitting the instrument not only to furnish quantitative information but itself to act upon this information in the absence of human control, may well appear to the future historian to be the most significant development of our technology. Of course the basic concepts of power amplification synchronized with an operational pattern is as old as the steam engine itself, for the ratio of the work done by the expanding steam to the work necessary to inject water to be evaporated is essentially a power-amplification factor and the synchronism of valves and pistons determines the phase relationship distinguishing regeneration from degeneration.

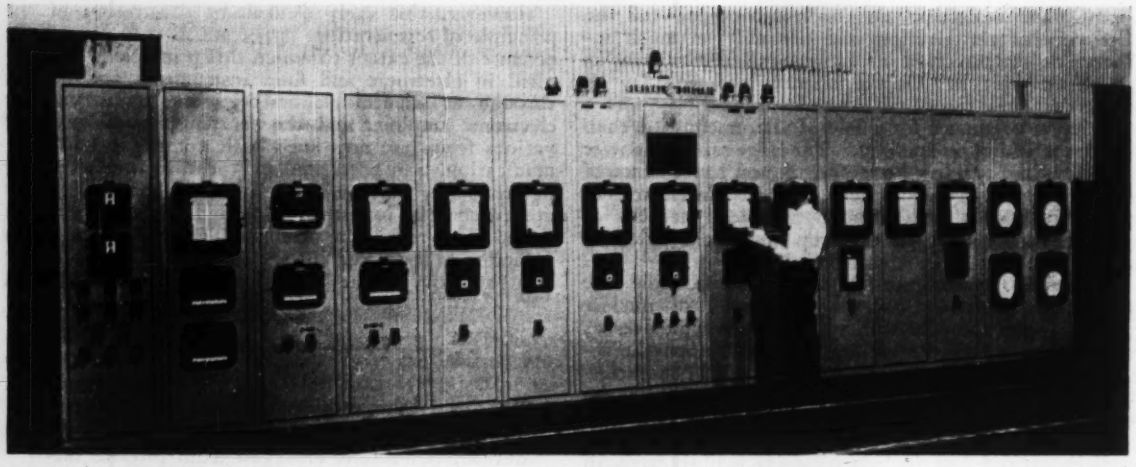
However, this early elementary illustration of the principle of regeneration, important as it is, gives little promise of the extent to which this principle is now applied in electronic and fluid instruments and devices throughout scientific laboratories and industry. The electronic amplifier and the servomechanism in their various forms are now such basic components in communication, transportation, and the utilization of power in our society that we realize it would be impossible to operate complex industrial plants and equipment without them. The reduction of human error and the great reduction in space and time and human effort which are brought about by the self-acting instrument constitutes a major social phenomenon in our technological society.

Physics is the mother of instrumentation not alone because the principles and rudimentary developments have emerged from physics laboratories, but also because the habits of thought, precision of definition, and rigor of analysis and synthesis have their genesis in the study of the physical sciences. These attitudes of mind no less than the technical products of industry have enabled the designers and employers of instruments to evolve methods and techniques for the employment of these devices and for their incorporation in the growing industrial and technical fabric now lifting the burden of drudgery from the backs of mankind.

The controlling instrument replaces a human being and in its proper role does an infinitely superior job in those functions which it is called upon to perform. Our technological development already has reached the stage where it would be impossible to conceive of telephone centrals or petroleum refineries or power stations operated by human beings without the existence of these devices, and we have probably made but a small start upon the opportunities which these present in raising the per capita efficiency of men.

Relieving Man's Burdens

The instrument used for control as a product of the physics laboratory bears some relationship to the role of physics in the development of precise thought habits among those familiar with its principles and methods. The instrument used for control liberates human beings from routine drudgery and enables the same number of technically skilled people to perform greater services for society as a whole. Our individual temperamental predilections are such that the time will never come when everyone is a scientist, but through the development of instrumentation and its use to control our processes, a small number of scientists may be able to perform the essential services to society which our technical civilization requires.



Panel with controlling, recording, and regulating instruments for practically automatic operation of continuous-annealing line

Continuous Annealing of Steel Strip— Controls for a High-Speed Line

Line cleans and anneals 30 tons of tin plate per hour

By H. C. Morrow

Product Representative, U. S. Steel Corporation, Pittsburgh, Pa.

THE continuous annealing of steel strip, in gages generally utilized in the tin-plate range, has been a common practice in several steel-processing plants for a number of years. However, the tonnages produced, per operating unit, were not large, and the operation did not make great inroads into the more common practice of box or bell-type annealing.

The many complexities involved in the building and operation of high-speed continuous-annealing lines, such as the metallurgical requirements, strip-tracking, and control features had been under consideration by equipment makers and steel producers alike, for an extended period. In 1951, through the combined resources of several equipment manufacturers and one major steel corporation, a line designed to operate at a production rate of 30 tons per hr, with but one exception triple that of any then in existence, necessitating strip speeds up to 1000 fpm, was installed and tonnages since obtained have proved the value of the continuous annealing operation as a major producing unit.

Contributed by the Metals Engineering Division and presented at the Semi-Annual Meeting, Pittsburgh, Pa., June 20–24, 1954, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Slightly condensed.

The Strip-Pass Line

The line embodies all the features normally found in a major producing unit, to process materials at a rate commensurate with that of other units throughout the plant on an economically sound basis. It is designed to clean and anneal strip varying in gage from 0.0076 to 0.015 in. and in widths from a minimum of 18 to a maximum of 37 in. The production rate of 30 tons per hr is based on the processing of 0.0010-in-thick × 30-in-wide material at 1000 fpm.

While, in actuality, the line functions as a single continuous unit, with a strip-pass line 3000 ft long, for purposes of description it can be considered as consisting of three distinct sections, namely, uncoiling, furnace, and recoiling. The uncoiling section consists of two expanding mandrel-type uncoilers, pinch-rolls, up-cut shears, welder, electrolytic cleaner, and tension bridle. The furnace section contains the entry and exit looping towers, appropriate tension bridles, pinch-roll assemblies, automatic strip-tensioning device, and the furnace. The recoiling section consists of a dual-tension bridle assembly and two collapsible mandrel-type winding reels, each of which is equipped with an electronic side-

register control for the elimination of strip weave during the recoiling operation.

Looping Towers

The entry looping tower contains approximately 400 ft of strip in two free-hanging loops. Its purpose is to supply strip to the furnace section during the welding period. Loop position is governed by photoelectric controllers which are located at various fixed positions on the tower structure and which have auxiliary control over the speed of the uncoiling section, increasing or decreasing it as the loop positions dictate.

The exit looping tower has the same storage space available as the entry tower, but the normal strip-pass line is in the up or top of tower position, providing space for annealed plate when the recoiling section is stopped for the reel-changing operation. This tower also is equipped with photoelectric devices which exert control over the recoiling-section speed for loop-position maintenance.

Cleaning Strip

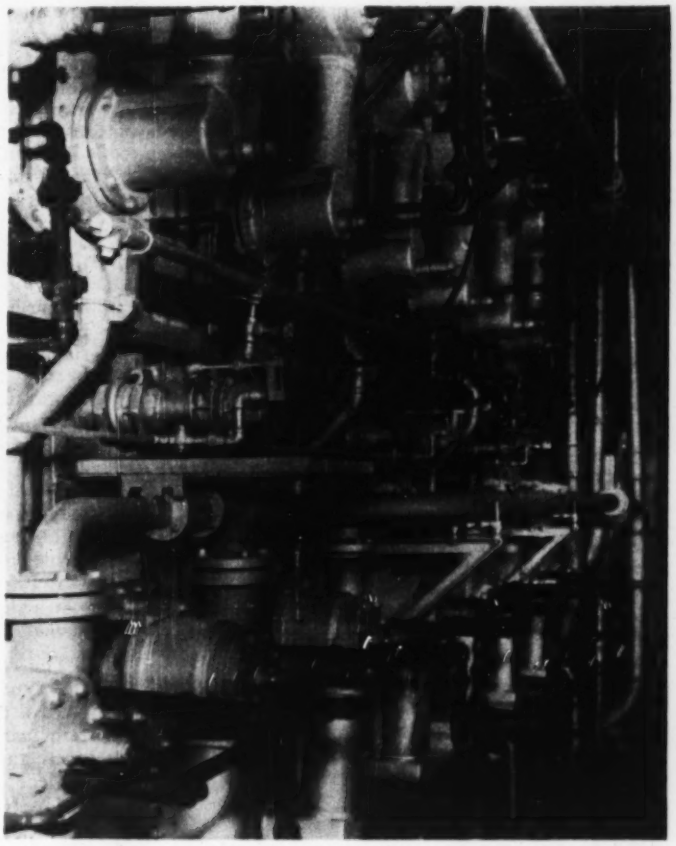
Strip to be processed is received direct from the cold-reduction mills still coated with the rolling solution. For this reason it was necessary to include an electrolytic cleaner as an integral part of the equipment. It contains four electrolytic and two nonelectrolytic passes. Current is supplied to two sets of grids from two 24-volt 7500-amp generators which are so connected, electrically, that the current direction is reversed automatically during each welding period stop. Approximately 7500 gal of solution, which is maintained at a salt concentration of 3 to 4 oz per gal, is contained in the continuously recirculating counterflow-type system. A basement reserve storage tank equipped with sediment-settling baffles is of sufficient size to hold all the solution during cleaner outage periods. The solution is continuously pumped from this tank to the strip exit end of the cleaner tank and then through a series of level-controlling weirs to the storage-tank return line. Control of the temperature of this system is accomplished by means of electronic-type instruments. The controlling instruments are of the air-operated type, actuating single-seated steam-flow-control valves on the condensate side of steam coils which are located in both the cleaner and storage tanks.

Following the electrolytic section is the four-brush scrubber unit with one set of brushes rotating on the top surface and the second set on the bottom surface of the strip. These brushes work in combination with high-pressure hot-water sprays which are supplied from auxiliary pumps and injector-type steam-water mixers. The control of the water temperature is accomplished by means of pilot-actuated valves whose temperature-detecting elements are located in the mixer-discharge line.

The final unit in the cleaner assembly is the "hot-water" rinse tank in which the strip, in two vertical passes, is immersed in a recirculating-type hot-water bath, the level of which is controlled by means of an overflow weir. Control of water temperature is accomplished in a manner similar to that for the cleaner section. As the strip is discharged from this bath, it passes through a series of hot-water sprays, which are supplied from the same-type system as that described for the scrubber section. Finally, it passes through a set of rubber wringer rolls, hot-air drier, and thence to the entry storage looping tower.

Strip-Tensioning

Of the 3000 ft of strip in the line, approximately 1800 ft is concentrated within the controllable tension zone of the furnace section. Strip is delivered to the furnace section from the entry looping tower by means of a dual drag-bridle assembly, and before entering the furnace proper, it traverses the pass line of an automatic strip-tensioning device. This device contains a movable roll assembly which is powered by means of a torque motor through a rack-and-pinion drive. Adjustment of the torque-motor field rheostat determines the initial tension applied to the strip, for its forces are such that it continually tends to drive the roll assembly in a down-



Close-up view of rayotube assemblies and supporting members in side wall of gas-fired heating zone

ward direction. The roll assembly also works in the light path of a modulating-type photoelectric controller, which governs the speed of the preceding bridle assembly. As a decrease in light reaching the photocell decreases the bridle speed slightly under line speed, the strip tends to tighten, thus developing a mechanical force opposing that of the torque motor. A decrease in tension requirements develops the reverse action. The modulating control feature is such that the two opposing forces are equal throughout any speed range for any given tension necessary.

Annealing Furnace

The furnace proper, with its four identified heating, holding, controlled-cooling, and fast-cooling zones, contains 1700 of the 1800 ft of strip, which is distributed according to the metallurgical demands of the product into thirty-four 50-ft-high vertical strands. The inclusion of this number of strip passes required the installation of forty-one rolls, each of which is equipped with a torque-motor drive. In operation, these motors overcome frictional and roll-weight loads but the strip, itself, provides the majority of the propelling force.

(A view from the entry end of the furnace, showing the gas-fired heating zone and heating tubes, appears as the frontispiece in this issue.)

Tracking of Strip

The tracking of strip in such quantity, with no possibility of mechanically correcting for errors, was early recognized as a trouble potential. Upon commencing operations, it was found that the line could not be operated at the designed speed of 1000 fpm. As a matter of fact, tracking was only fairly successful up to speeds of 300 fpm, after which the weave became excessive, even to the point that the strip would oscillate off the ends of the rolls into the furnace side walls. Attempted corrective measures, external to the furnace, such as a tilting roll, were entirely ineffective; and it was therefore decided that the "Lorig" automatic self-centering roll theories should be adopted. The initial installation of one split-shell-type centering roll, in combination with a narrow-bodied roll, immediately preceding the furnace, reduced the strip weave, entering the furnace, from a maximum of 5 in. to approximately $^3/_4$ in.

The Lorig Theories

Pursuing the Lorig theories that the guiding of strip, except in a few minor exceptions, should be accomplished with rolls free of strip edge pressures, the first several rolls in the heating zone were narrow-bodied and the tracking conditions immediately improved. Complete control of strip tracking at the 1000-fpm speed, as well as other desirable features, such as the exceptional improvement in strip shape and flatness, were the eventual benefits derived from the adoption of the narrow-bodied feature throughout the complete furnace-roll train.

The Lorig principles were further used in other sections of the line, such as the cleaner and tension bridles, and, in each case, improved operations to the extent that they are now accepted as a standard requirement for processes of this type.

Furnace-Sealing Rolls

The furnace must be operated as a gastight unit, and it is therefore provided with a set of sealing rolls at both the entry and exit ends, which exert a slight pressure upon the strip and which rotate in synchronism with the strip speed.

All other openings in the furnace, such as those for the burners, roll shafts, electrical heating-element connections, viewing glasses, and so on, are sealed to prevent leakage. Atmosphere gas is supplied to the unit from a main generating station and the total flow is measured by means of an orifice-type recording flowmeter located on the main control panel.

Controls and Recording Instruments

Distribution of this gas to the various furnace zones is controlled by means of flow valves and indicating meters of the rotameter type. Recording-type oxygen, hydrogen, and total combustibles meters also are provided and are connected to a common metering header from which it is possible to select any of six different sampling connections throughout the furnace.

The gas-flow and analyzing-recording system has proved to be a valuable asset for it continually produces a record of the furnace atmospheric conditions which are so much a measure of the quality of the product being produced.

Furnace pressures also are continuously recorded by means of a system which embodies an additional selective-sampling header and dual-pen pressure recorder, thus permitting the recordings at any of several different points on either the top or bottom of the furnace. Pressures normally are controlled and the flow of atmosphere gas altered according to the furnace-bottom conditions. The top of furnace indication also is essential as it forewarns the operator of excessive pressures which could result in ruptures to the sealing mediums.

Nominal capacity of the entire furnace is 30,000 cu ft and a flow of atmosphere gas of 15,000 cu ft per hr develops a bottom-furnace pressure of approximately $^1/_2$ in. water column.

Heating Zone

The heating zone contains six strands of strip which pass over rolls spaced on 49-ft center lines. The effective heating length of each pass is 46 ft, producing a heating zone equivalent to that of a 276-ft-long horizontal furnace. A total of 107 radiant-tube heating elements are uniformly spaced along this pass line. Normally, each of these elements is operated at an input of 230,000 Btu per hr which is equivalent to an electrical input of about 67 kw. On this basis the total input may be considered as 24,500,000 Btu per hr or 7200 kw. In normal operation and at rated capacity, the requirements are 700,000 Btu per ton when heating strip to 1250 F.

Radiant-Tube Elements

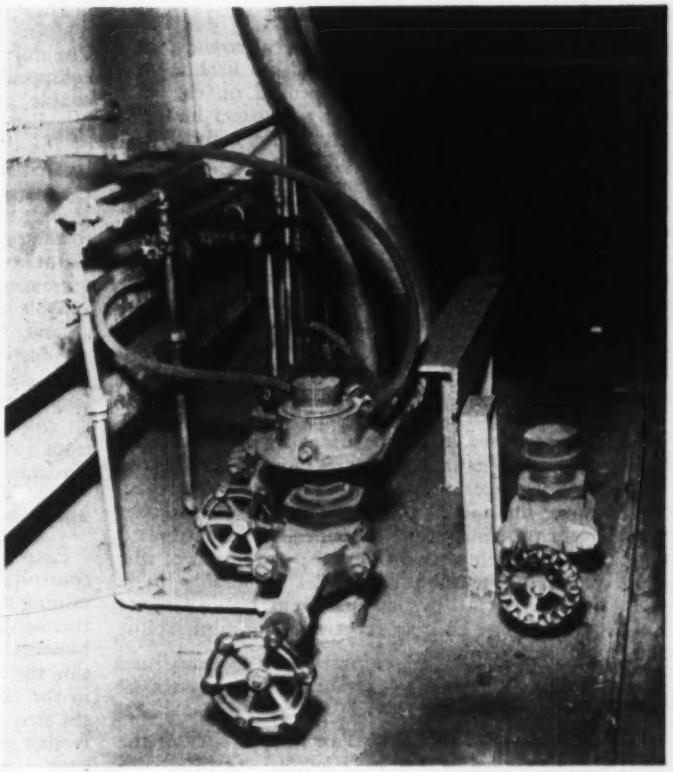
The radiant-tube elements are specially designed for this type service and are equipped with automatic ratio-control devices and exhaust-gas heat exchangers to attain maximum fuel economy when burning raw coke-oven gas containing large amounts of sulphur, naphthalene, and tars. Both the radiant-tube elements, themselves, as well as the burners and heat exchangers, are designed for continuous service without outage for cleaning purposes. To facilitate maintenance, each element, including the radiant tube, burner, heat ex-

changer, and ratio-control device, is mounted as an integral assembly on a refractory-lined bung, fitting into the furnace wall and is so arranged that it can be removed as a unit with a rig similar to that of the roll-changing booms without disturbing the exhaust or fuel-supply piping.

Controls

For control purposes the 107 elements are divided into six zones, the location of which generally approximates the path of the strip through the chamber. Temperature-controlling equipment, per zone, consists of a radiation-type temperature recorder-controller, duration adjusting time-type relay and high-speed valve-drive mechanism. The radiation units, which are of the closed-end type, are provided with air-cooling heads and injector-type nozzle assemblies making possible the use of small amounts of atmosphere gas for purging the closed-end tubes, a practice which has been found so essential for the prevention of lens condensation.

The automatic temperature controllers function in conjunction with ratio-controlling devices which are designed to maintain constant fuel-air ratios, with widely varying air temperatures, over a turndown range to approximately 20 per cent of maximum flow. At ratings below this point, air is increased over normal in order to insure steadily oxidizing conditions at all times on the interior of the radiant-tube elements. The use of this accurate ratio-control system enables economical operation even though the pulse or on-off control rate is extremely high; consequently, the temperature-control system may be operated to give optimum results, from the standpoint of control accuracy, without regard to the effect on the radiant tube.



Direct-sight-type rayotube installed in tunnel roof between heating and holding zones. Air-cooling piping to jacket and inert-gas-atmosphere connections also are shown.

Combustion

The combustion air and fuel gas are propelled through the radiant-tube elements by means of suction applied at the exhaust outlet and it can therefore be seen that with all sections of the tube, internal to the furnace, being under suction or negative-pressure conditions, under no circumstances can contamination of the furnace atmosphere occur because of leaks in the combustion system. The exhaust gases are led through streamlined aircraft-type exhaust manifolds to jet-pump exhausters which provide the necessary suction and in addition raise the pressure of the flue gases sufficiently to exhaust them, through ductwork, from the building.

In addition to serving as heating elements, the combustion system also provides accelerated action in the event it is necessary to cool the furnace chamber quickly for any reason. By remote push-button operation and also automatically in the case of a line stop, it is possible to shut off the fuel gas and to increase the combustion-air supply approximately 40 per cent over normal, which provides a quick-quenching of the zone by means of the radiant-tube elements. To permit this rapid cooling of radiant-tube structure or supports, the tubes are free to expand in any direction with respect to their mounting plates.

Holding Zone

As the strip leaves the furnace zone, it enters a tunnel leading to the holding zone. Installed in the roof of this tunnel is an open-end or direct-sight radiation receiver which is electrically connected to an additional temperature recorder on the main control panel. This unit is in an ideal location for this type temperature measurement due to the tunnel length, and the only radiation effective to it is that received from the strip itself, thus resulting in a nearly constant emissivity factor. The receiver, which is focused directly on the strip, is mounted on a pipe-stool arrangement which contains an atmosphere-gas connection, its purpose being to pressurize the tube to an amount of slightly greater magnitude than that of the furnace pressure, thus preventing the hot furnace gases from fogging or damaging the lens system. Calibration of this unit is accomplished by means of a low-range optical pyrometer which can also be sighted on the strip in close proximity to the field of sight of the radiation unit. All line operations are based on the temperatures recorded by this instrument and therefore heating-zone temperatures and line speeds are adjusted in accordance with its indications.

Soaking Section

The holding zone, with its six vertical strands, provides a soaking section 300 ft in length. Ribbon-type electrical elements, which are suspended on the four side walls by either refractory or alloy-steel hangers, provide the heating means and these, for control purposes, are divided into four distinct sections. The total input available is 900 kw, and the speed of heating response may be altered manually by means of a control which provides either a Y or delta-input connection. Four temperature controllers of the two-position or on-off type with iron-constantan thermocouples, which are mounted in the zone side walls and which protrude through the brickwork to a point where they are receptive to the zoned-element temperatures, complete the control complement. The connecting tunnel between the holding and controlled cooling zone contains a radiation-type temperature receiver unit duplicating that previously described in the heating-zone exit position. Calibration of this unit, however, is more difficult as the viewed strip temperature is below the commonly accepted range for optical pyrometers which necessitates the use of a proximity-type thermocouple of calibrated length and indicating potentiometer. Adoption of this type calibrating method required considerably more study than the optical pyrometer system, but experience has proved it to be entirely repetitive and duplicatable and therefore acceptable.

Controlled Cooling Zone

Strip temperatures in the two vertical strands of the controlled cooling zone may be raised or lowered according to demand either by electrical heating elements suspended on the zone side walls or by a series of air-cooling tubes which are so mounted horizontally in the zone that each strand of strip passes between a cooling-tube bank. Control for this operation required the utilization of a duplex interlocking system of instruments wherein a proportioning type recorder-controller regulates the flow of air through the cooling tubes and two on-off-type indicating instruments, with thermocouples located in the zone side wall, control the operation of the heating elements.

Fast-Cooling Zone

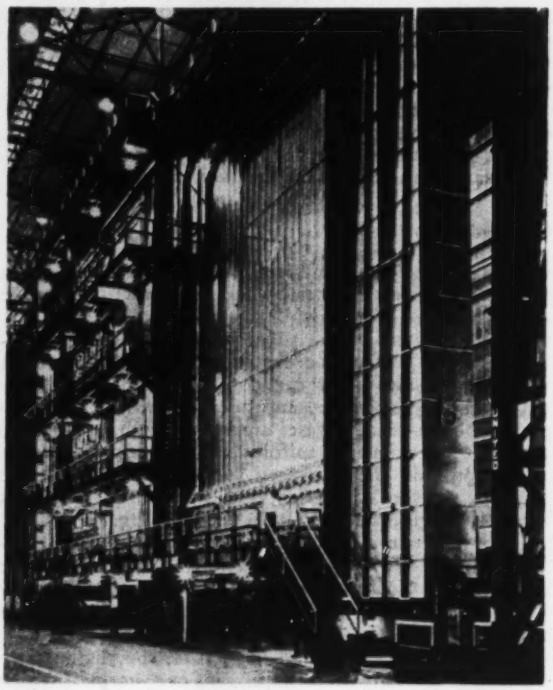
The function of the final furnace section, identified as the fast-cooling zone, is to reduce the temperature of the strip under controlled-atmospheric conditions, to such a level that the strip can be exposed to normal room air without the formation of undesirable surface oxides. To accomplish this, the strip traverses twenty individually water-jacketed vertical chambers which afford, through connections with the roll-container housings at both the top and bottom of each chamber, a continuous pass line of 1000 ft. Early recognition was given to the necessity of applying a controlling medium to the water supply for the jackets, as unrestricted flows permitted excessive cooling, creating buckling conditions in the light-gage strips. The natural tendency of the strip edges to cool more quickly than the strip center, causing excessive edge tensions, was also a factor as these tensions did not permit strip movement for alignment purposes on the carrying rolls and the diagonal tension strains therefore often resulted in severe buckling and strip breaks.

These faults were eliminated by the installation of temperature controls and a water-recirculating system. The ducts are now divided into two zones and each is equipped with an electronic-type instrument, thermocouple, and air-operated control valve. The valves are installed in the header supplying water to the bottoms of the ducts while the controlling thermocouples are located in the overflow lines at the top. This permits the instrument to control the flow of water according to any set temperature point. The overflow water returns to the recirculating system, the temperature of which is maintained at a point somewhat below the duct requirements by means of a third instrument and valve capable of supplying the cold make-up water to the system.

Additional cooling benefits are derived by the recirculation of the atmosphere gases in this zone and two fans are provided for this purpose. Their operation may be controlled either manually or by automatic means from a switch mounted on the line-speed motor-operated rheostat.

Air-Cooling Section

External to the furnace proper, but still within its controllable tension zone, is an air-cooling section containing two vertical strands. The strip, in these passes, travels between two sets of chambers supplied from blowers whose inlets are such that air is obtained outside the building and is blown upon the strip from slots in the chamber walls. This air-cooling system reduces the strip temperature to a point where it can be processed further through the handling equipment and recoiled at such a temperature that extensive cooling periods, before temper-rolling, are eliminated.



View from delivery end of furnace showing water-cooled and air-cooled conveying passes

The New Atomic Energy Law—

What It Means to Industry

By Everett L. Hollis

General Electric Company, New York, N. Y.

The Atomic Energy Act of 1954 is a wholly new Act—not a mere tinkering with the old Act. This new Act does two main things:

1 It affords private industry a larger role in the development of atomic energy.

2 It provides a framework for a greater degree of co-operation with other nations in the field of atomic energy.

Probably the dominant change in the new Atomic Energy Law is that the Government monopoly in the field of atomic energy has been substantially reduced. In 1946 the Congress felt that the Government must retain ownership of both fissionable material and of the facilities, like reactors, which produce that material in significant quantities. The new Act, while continuing to stress the necessity for close Government scrutiny, moves in the direction of control by Government regulation rather than control by Government ownership. Private industry may now own and operate "production facilities"—like reactors. The new Act does not, however, go all the way in eliminating the Government monopoly since it retains the requirement for Government ownership of all "fissionable material"—now called "special nuclear material." This new term is broadly defined so that materials essential to the fusion process could be found to be "special nuclear material." The term fissionable material has been dropped since it was deemed to have too restrictive a connotation—that of covering the fission process only. Apparently one of the decisive reasons for retention of Government ownership of this material was the fear of an emergency in which all special nuclear materials might be needed for military use. It was felt that retention of ownershp would make it easier to recapture all that material, if the need should ever eventuate.

It should be emphasized that the new Act does not remove the Government from civilian atomic development. It does not represent a shift of authority and responsibility for atomic development from the Government to industry. The concept of the new Act is that both the Government and industry must work concurrently and co-operatively in this development. As stated by the Joint Committee on Atomic Energy in its report accompanying the bill, the new provisions "aim at encouraging flourishing research and development programs under both Government and private auspices." The premise is that the efforts of both Government and industry will be necessary to a speedy and resolute attack on the problems of developing the civilian atom. Teamwork is the key.

Based on a paper presented before a meeting of the Atomic Industrial Forum, New York, N. Y., September 27–28, 1954.

Control Features of Act

In analyzing the control features of the Act it is well to remember that the reasons for the controls are stated, in many places, to be twofold: (1) To assure the common defense and security and (2) to protect the public health and safety.

It will be helpful to view the new Act in the light of two kinds of controls—controls over facilities and controls over materials. For both the basic control mechanism is licensing by the AEC. In other words, a formal AEC permission is needed to engage in certain activities. Taking facilities first—the new Act refers to two kinds of facilities—production facilities and utilization facilities. In general, the former refer to equipment or devices capable of producing special nuclear material. Utilization facilities refer to equipment or devices capable of using that material or atomic energy.

The concept of utilization facilities appears to be broader than that of production facilities. Utilization facilities are those which use either atomic energy or special nuclear material, whereas production facilities relate only to the production of special nuclear material. Since atomic energy is also broadly defined it may be that many kinds of devices will be treated as utilization facilities. At least, at this time, utilization facilities should not be thought of as being limited to reactors.

Both types of facilities are defined very generally and the AEC is given broad authority to spell out in detail what specific devices and equipment are covered. Thus, for example, the AEC may conclude that a particular facility will not be capable of producing special nuclear material in such quantity as to be of significance to the common defense and security, or in such manner as to affect the health and safety of the public. In that case an individual would not be required to obtain a license for a production facility although he might have to obtain a license for materials. The Act does not require a license for all facilities which use or produce special nuclear material.

Also the definition of both types of facilities includes important component parts of the total facility. There is a separate provision which appears to embody a con-

gressional recognition that some component parts may really be conventional industrial parts not needing the same degree of regulation as those portions of a facility which are peculiarly nuclear. The new Act accordingly provides that the AEC may determine that certain component parts need not be subject to a specific licensing system but that the AEC may issue a general over-all license to cover all companies or individuals who desire to engage in the specified component-part business. By this general licensing device the burden of individual applications may be eliminated.

Licensing

In general, if you want to do almost anything with devices defined by the AEC as production or utilization facilities, you will need a license. Among the purposes for which licenses are expressly required are manufacture, possession, and transfer. The statute does not define the exact extent of the projected licensing system. This will have to be spelled out by AEC regulation.

The kind of license that may be required for a facility will depend on the use to which the facility is put. Here it is important to distinguish between "commercial licenses"—and licenses for medical therapy and research and development. Commercial licenses relate to facilities which the AEC has declared to be sufficiently developed to be of practical value for industrial or commercial purposes. Several important differences flow from the distinction between these two types of licenses. As an example, you may receive less assistance from AEC if you have a commercial license than if you have a research and development license. To be specific, the Act requires the AEC to charge for special nuclear material distributed to a commercial licensee. AEC may, if it desires, distribute material free of charge to research and development licensees.

To take another distinction between these two types of licenses: Before commercial licenses can be issued by the AEC, it must inform the Attorney General and he in turn must advise the AEC whether issuance of the proposed license would "tend to create or maintain a situation inconsistent with the antitrust laws."

In addition, a separate license is required for individuals who manipulate the controls of a licensed facility. The idea of this requirement is apparently to establish a licensing system similar to that of the Civil Aeronautics Authority for airmen—in order to assure that only fully qualified persons will actually be operating atomic facilities.

Materials

Three kinds of materials are dealt with—source material, by-product material, and special nuclear material. The Act provides a licensing system for each type. Both source materials, like uranium ore, and by-product materials, like radioisotopes, may, as under the 1946 Act, be owned and used by private persons—subject to an AEC licensing system. The new Act contains separate provisions expressly authorizing the foreign distribution of isotopes both by the Government and by private owners of facilities which produce isotopes. Controls over source material and by-product material do not appear to have been changed substantially.

For the third kind of material—the special nuclear material—private ownership is absolutely prohibited. This ban on private ownership applies not only to material produced in Government-owned facilities but also to new material which a private owner may produce in his own facility. This results in the unusual situation of the production of a privately owned plant being "property of the United States."

Even though all special nuclear material must remain the property of the United States, the new Act does provide a greater promise for more widespread availability of this material to private persons. Eliminated is the requirement of the 1946 Act that no private person may receive an amount of material sufficient to construct an atomic weapon. Furthermore, there is express provision in the new Act for a determination by the President at least once each year of amounts of special nuclear material that may be distributed by the AEC.

It is worth noting that both source and special nuclear materials are defined in the new Act in such a way as to enable the Commission to declare additional materials to be either source or special nuclear material. Hence new materials which may in the future be needed in the atomic or thermonuclear program can be brought under the control provisions of the Act. The potential industrial consequences of adding materials to the present list of special or source materials are great. Suppose, for example, that the Government decided to declare a new material to be special nuclear material; at that point private ownership of that material would be barred, and just compensation would have to be paid to all private owners. Before new materials could be added, however, the AEC must get the approval of the President and must formally advise the congressional Joint Committee on Atomic Energy.

It is clear that the situation of a privately owned factory using, and also producing, material which is entirely owned by the United States will create many problems not the least of which is that of pricing; for industry will have to pay the Government for the special nuclear material it uses, and the Government will have to pay for material which industry produces. The amounts of these payments are not spelled out in the Act—only general rules are set forth. For example, if you are a commercial licensee you must pay the AEC a "reasonable charge" for the use of the special nuclear material you acquire from the AEC. Conversely, the AEC will pay you a "fair price" for the special material which you may produce in your privately owned facility.

Furthermore, the AEC is authorized to establish guaranteed prices for all special material delivered to it within a specified period, not to exceed seven years from the date of the announcement of the guaranteed price. This guaranteed-price technique has been employed for some years now by the AEC in regard to raw materials delivered to it. This provision may be of importance in the fashioning of arrangements for dual-purpose reactors.

Other important licensing provisions deal with such

questions as the duration of licenses, the various means by which licenses may be revoked, and with such problems as what compensation, if any, private persons may receive in the event of a license revocation. These are, of course, important questions to anyone considering the investment of substantial sums of money in an atomic facility.

The Act contemplates activity by both Government and industry—concurrent and co-operative activity. The Act recognizes that the AEC may be in a position to provide materials and services to industry which industry cannot get elsewhere, and authorizes AEC to make such materials and services available to industry. The AEC may, for example, enter into agreements for the private use of fabricating or refining facilities owned by the AEC. The Act also authorizes AEC to conduct in its own facilities and laboratories, research and development projects for private companies. These powers may prove to be of great practical importance in the fashioning of co-operative arrangements between AEC and industry to speed atomic development. Such arrangements must, however, be drawn in the light of the "no subsidy" provision of the Act which, in general, provides that no AEC funds shall be employed in the construction or operation of licensed facilities. This no subsidy provision does not, however, limit the use of AEC funds for contracts and other arrangements entered into pursuant to the AEC's general authority to provide research and development assistance.

AEC's Role in Distributing Power

The provisions relating to AEC assistance to industry lead now to a brief discussion of AEC's own role in distributing power. There was considerable discussion in the Congress on this issue. In general this is the way the Act resolved it. The AEC may build experimental power facilities in furtherance of its research and development responsibilities. It is authorized to dispose of power produced at these experimental facilities, as well as power produced as a by-product of AEC production of special nuclear material. The AEC is excluded from engaging in the atomic-power business as an independent function. It is provided, however, that Government agencies other than AEC—such as TVA—may obtain licenses from the AEC to engage in the distribution of power if those other agencies are authorized by law to do so. The effect of these provisions is to postpone for future legislative consideration the role of the Government in producing, marketing, or distributing electric energy.

Control of Information

There is a broad and special category of information called "restricted data" over which the AEC has great control. The concept of restricted data goes back to the 1946 Act and is retained in the new Act. This category of information is very broadly defined to include not only all data concerning design, manufacture, or utilization of atomic weapons, but also data concerning the production of special nuclear material or the use of special nuclear material in the production of energy. Excluded from this definition are data declassified or removed from the category of restricted data by action of the AEC.

In the new Act Congress recognizes the importance of the free flow of information to the fullest extent consistent with the national security. Express recognition is given to the importance of disseminating information in furthering industrial progress as well as to scientific progress. Furthermore the new Act clearly recognizes that questions of releasing information from the restricted-data category frequently involve a difficult balancing of benefit to the nation against the disadvantages of informing unfriendly nations. A test of not releasing any information which might be of benefit to another nation is not the answer. Viewed narrowly, it can plausibly be argued that the release of almost any information, including the morning's newspaper, may be of some assistance to an unfriendly nation. The new Act meets this general problem by establishing, as a declassification criterion, whether the information may be published "without undue risk to the common defense and security." For the first time, the AEC is expressly charged by law with the affirmative responsibility of determining, from time to time, what information can be declassified—and thus published—in accordance with the "undue risk" criterion. Included also, for the first time, is a provision that the AEC shall have no power to control or restrict the dissemination of information outside of any powers granted by any law.

It should also be pointed out that there is a direct relationship between the control of information provisions and the fulfillment of one of the basic purposes of the Act—that of encouraging "widespread participation" in atomic development. For if it is possible to declassify and publish information needed by those desiring to engage in atomic business there will be a greater chance of such widespread participation. Where it is not possible to declassify and publish needed information, it must be handled in accordance with Government requirements and clearances. And the difficulties of obtaining widespread participation may be substantially increased. Furthermore, the publication of information probably has the effect of reducing the anxieties that have been expressed concerning the commercial advantage—or appearance of advantage—possessed by those who have access to classified information.

Personnel Clearance

The new Act also contains several important changes with respect to personnel-clearance requirements. Under the original Act the same clearance and investigation requirements applied to all personnel employed by the AEC and its contractors whether those employees would have access to very sensitive atomic information or only to small amounts of restricted data of minor-security significance. The new Act recognizes that there are varying degrees of sensitivity of information within the restricted-data category. The AEC is accordingly authorized to establish the scope and extent of investigations to be conducted, depending upon the degree of importance to the common defense and security of the restricted data to which access will be permitted. This authority may enable the AEC to streamline its clearance system and possibly to provide quicker clearances where the information involved is of a relatively low order of security significance. On the other hand, it may be that the creation of different categories of atomic clearances will pose new administrative problems for the Commission and for those in the atomic industry—problems, for example, of segregating people with different degrees of atomic clearances.

Another clearance change is that the AEC may now authorize contractors and licensees of the Commission to

give Department of Defense personnel access to restricted data based upon their military clearances instead of requiring a separate and additional AEC clearance. This change may result in easier working relationships between AEC contractors and licensees and the military.

The requirement for security clearance of licensees is extremely important. The new Act provides that prospective licensees for facilities must agree in writing not to permit any individual to have access to restricted data until that person receives AEC security clearance. Thus the personnel-clearance system of the AEC will extend beyond employees of the Government and of Government contractors to employees of AEC licensees even though those licensees will be operating privately owned facilities.

Government Organization

With respect to Government organization, the relationship between the AEC and the other agencies of the Executive Branch, notably the Defense Department, remains essentially the same. In so far as the organization of the Commission is concerned, the General Advisory Committee and the Military Liaison Committee are not substantially changed. Express recognition is given to the Office of General Counsel, in view of the importance of the many complex legal problems which the new licensing and regulatory provisions will present. Created for the first time is an Inspection Division. This Division has the duty of gathering information to ascertain whether contractors and licensees are complying with the provisions of the Act and the rules and regulations of the AEC. Apparently, complaints regarding the operations of licensees under the Act can be referred to this Division. Provision is also made for the organization of a division or divisions charged with the primary responsibility for the development and application of civilian uses of atomic energy.

In so far as the role of Congress is concerned, the Joint Committee is certain to be far more than a side-line spectator. The new Act emphasizes the continuing interest of the Joint Committee in the "state of the atomic-energy industry." The Committee is required to hold hearings—open or closed—during the first 60 days of each session of Congress to inquire into the development and growth of the atomic-energy industry.

As under the old Act, the AEC is required to keep the Joint Committee fully and currently informed. A similar affirmative responsibility is now placed on the Defense Department. Furthermore, all other Government agencies are now required to furnish the Committee, at its request, any information with respect to their activities in the field of atomic energy.

The new Act further strengthens the role of the Joint Committee by requiring that advance notice be given to the Committee before certain actions can be taken. Two examples are: First, the addition of new materials to the list of source and special nuclear material; and second, the granting of long-term contracts for the purchase of power, such as the Dixon-Yates proposal.

Another change which presumably will result in closer scrutiny by the Joint Committee is the requirement that AEC obtain specific congressional authorization for the acquisition or condemnation of real property, as well as for plant construction or expansion. Heretofore the 1946 Act provided a broad and continuing legislative basis for AEC's construction and expansion programs, and AEC had only to go back to Congress for periodic appropriations.

With the new requirements of specific authorization, presumably the AEC must now go through a two-stage congressional process. First, it must appear before the Joint Committee and seek to obtain a statute approving the particular project. Second, it must go before the Appropriations Committees and seek to obtain from the Congress the appropriations necessary to carry out the particular project.

The Congress has now set forth a new national policy for the development of civilian atomic energy. It was dealing with many unknowns and imponderables. Therefore it is not surprising that the new Act should be framed in broad terms.

Furthermore, the Congress was dealing with a complex and intricate subject. And it is not too surprising that the Act should contain ambiguities.

Congress has supplied the direction and the general boundaries. The Executive Branch—and in particular the AEC—is given great discretion to supply the specific content. A reading or study of the new Act will not yield answers to many of the questions which industry and others have. In this sense the Act represents only the beginning.

A full appraisal of what industry can do under the Act cannot now be made. This must await the issuance of the detailed AEC regulations and the accumulation of some experience in administration.

In commenting here upon the responsibilities and the vast discretionary powers entrusted to the AEC, we must not lose sight of the opportunities and obligations of industry to help in effectuating the new national policy for developing atomic energy. This obligation of industry cannot be discharged only on the scientific and technological front. Also needed are ingenuity and imagination in devising techniques—legal, economic, financial, and otherwise—for fitting the civilian atom into the more normal framework of American life.

Editor's Note: The provisions of the bill relating to patents and inventions, private-company activities outside the United States, and greater details on licensing were also discussed at this meeting. The substance of these presentations will appear in a Proceedings to be published by the Atomic Industrial Forum.

Theory of Maintenance of Rolling Stock

By Roger R. Crane[1] and Frank B. Brown[2]
Westinghouse Air Brake Co., E. Pittsburgh, Pa.

When and how much maintenance of rolling stock should be performed is a problem involving human judgment, which can be aided greatly by scientific analysis. The theory of failure and its application to complex equipment is a field which has been explored in several connections and has been applied in many industries. The authors indicate some of the applications of this theory to replacement and maintenance programs for rolling stock on the railroads.

In general, the "life" of a physical system may be defined as the maximum amount of service which may be derived from the system before it fails to perform the basic task for which it was designed. For example, a rail has failed when it no longer can support the weight of a train; a brake shoe has failed when it is so badly worn or cracked that it no longer can be held in position on the wheel. The life thus represents the ultimate service which possibly can be attained.

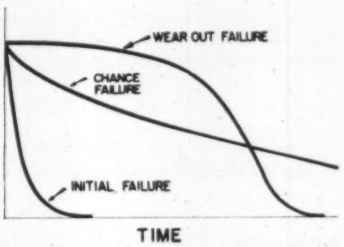


Fig. 1 Life curves of equipment, illustrating three general types of failure

In the case of complex equipment, made up of many individual components, the continued operation of the system may depend on the continued operation of each of its components. Such a system is said to be serially connected—failure of any one component corresponds to failure for the system. Thus a radio no longer is serviceable, and hence has failed, if any one of the tubes has failed.

While the failure of equipment may occur in many ways, three general failure types can be distinguished. They are illustrated by typical life curves in Fig. 1.

Contributed by the Railroad Division and presented at the Fall Meeting, Milwaukee, Wis., September 8–10, 1954, of The American Society of Mechanical Engineers. Condensed from ASME Paper No. 54—F-1.

Types of Failure

(*a*) ***Wear-Out Failure.*** A long service, accompanied by continuous wear, until removal is finally necessitated. One obtains this curve (Fig. 1) when the equipment is installed in good condition and physically wears out from use or age.

(*b*) ***Chance Failure.*** Here the chance of failure is independent of the length of service. Rail torn up by an accident exemplifies this type of failure. The basic characteristic of chance-failure curves is that the equipment has a fixed probability of failing at any time, independent of its age. If the failure of parts is found to occur according to this chance-failure law, there is no advantage to be gained by expending funds in preventive maintenance on them. The parts fail at the same rate, whether they have just been installed or have been in service for some time. Maintenance has no effect on the life and hence both its cost and the lost time of the equipment would be wasted.

(*c*) ***Initial Failure.*** Caused by some flaw present when the equipment was first placed in service. For example, a wheel which has not been turned properly, or a rivet which was installed improperly, would be expected to fail relatively soon. The initial-failure curve frequently includes the properties of a chance-failure curve but exhibits a higher failure rate.

It is apparent that maintenance of equipment to forestall failure will prove advantageous only for equipment which is wearing out and will be of no value for equipment falling in class (*b*) or class (*c*). For this reason the following will be concerned solely with equipment exhibiting the characteristics of wear-out failure.

Value of Inspection

We have defined the life of an article as the ultimate service which can be extracted from it. In most cases railroad equipment will be withdrawn from service some time before its life is ended—that is, before it fails on the job. For this reason the life curve of a piece of equipment is often difficult to obtain, and one is forced

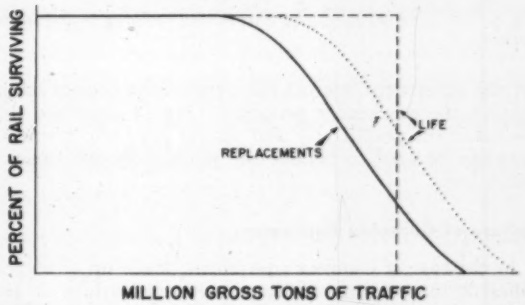


Fig. 2 Curves indicating life of equipment and replacement curve for similar pieces of equipment

to consider instead the replacement curve for the equipment. This curve may or may not have a form similar to the life curve. As shown in Fig. 2, the replacement curve indicates the length of time which similar pieces of equipment have lasted before being replaced.

The decision to replace equipment may be made in many ways. As examples, it may be made at random, it may be after a fixed period of service, or it may be based on a measure of the relative wear which the equipment has suffered—that is, on how near the equipment has approached its ultimate life. The latter procedure provides the longest potential life consistent with a minimum danger of failure in service. To avoid such an in-service failure, with its attendant costs and dangers, and to obtain safely the longest possible service from a piece of equipment, it is necessary that equipment be inspected periodically to ascertain its individual rate of wear. Inspections are needed more and more frequently as the equipment gets older and approaches its expected life duration. Inspection involves cost, of course, and the problem becomes one of balancing the advantages of longer service against the increasing cost of inspection and the possibility of in-service failure.

The Value of Maintenance

Maintenance may be applied to a system either before or after failure; that is, the maintenance may be either of a preventive or a corrective nature. In most cases, however, the cost of allowing an in-service failure to occur is so high that one would resort to a system of corrective maintenance only in an emergency.

The purpose of applying preventive maintenance to a system is to extend the life of the system. As the system becomes older it will require an increasing amount of maintenance to keep it in operating condition. The problem arises of balancing the advantages of longer life

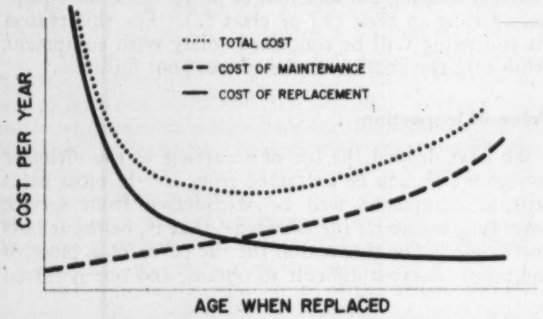


Fig. 3 Effect of maintenance cost in determining replacement period

for the equipment against the pyramiding cost of maintaining the equipment properly. Fig. 3 describes this phenomenon graphically and shows how the resulting data can be used to predict the most economic maintenance level.

Failure of Complex Equipment

In the case of complex equipment, made up of several different components connected serially, failure of any one component brings about failure of the system. Thus the "reliability," defined as the probability that the system will survive for a time t, decreases rapidly as the complexity of the system increases. This can be illustrated in the following manner in the simple case where all components individually have the same failure characteristics and are new at the start:

Suppose that the system consists of n identical components connected serially, each with the same average life and each having the same probability of deviating a given amount from that average. Then if $p(t)$ is the probability that a given component survives for a time t, the probability $P(t)$ that the entire system will survive for the time t is given by

$$P(t) = [p(t)]^n$$

This function is plotted for various values of n in Fig. 4.

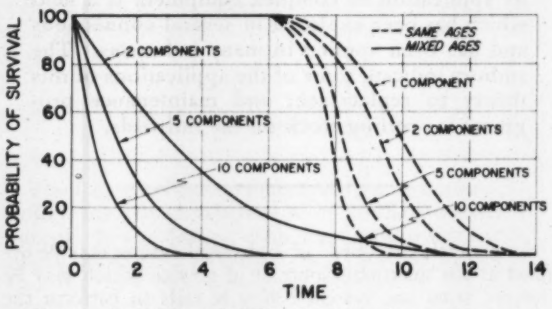


Fig. 4 Survival probability for complex equipment

From this figure it is seen, for example, that if the probability is 50 per cent one wheel on a freight-car truck will last for 10 years, then the probability that all four wheels on the truck will last for 10 years is only about 6 per cent. As the system becomes more complex, the reliability decreases rapidly. It also will be noted that at the same time the uncertainty or amount of variation in the possible lifetime decreases. For example, if a very large number of parts, each having the characteristics shown by the dotted lines in Fig. 4, were connected serially, this system would be virtually certain to fail after 6 years.

In some situations it may be decided to replace each part as it fails. Under these conditions the equipment eventually reaches a steady state and new components are thereafter added at an essentially uniform average rate. The probability of a failure of the system becomes constant with time, and the life curve for the system approaches an exponential form, as shown by the solid curves in Fig. 4. The mean life of the system remains sharply dependent upon the number of components of which it is composed. In all cases it is much shorter than for the situation where all the components started new.

In other situations, it may be more economical to replace components as they fail up to a certain time and then replace the entire system.

Components With Varying Life

So far, our discussion has been confined to the relatively simple situation where all of the components of a system have the same life curve. In practice this usually will not be the case. For example, the life of the entire

(*Continued on page 1009*)

Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Associate Editor*

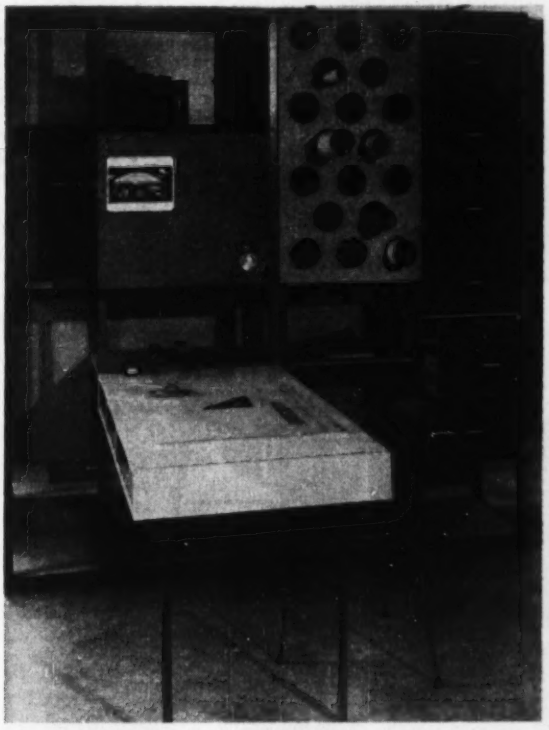


Fig. 1 This unit is a wall or free-standing fitment for a drawing office, or any office concerned with storage of plans. It consists essentially of a timber frame containing Bartrev backing, shelves, sliding doors, and filing drawers, which are entirely of Bartrev.

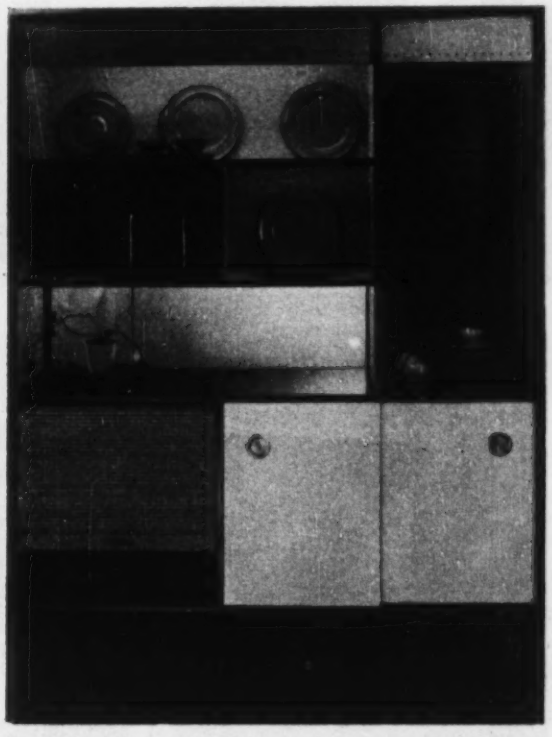


Fig. 2 In this example a framework was composed of angle iron. All shelves and panels were thus placed in necessary positions without the need of jointing one to the other. Here Bartrev will be found to be a suitable material for the intricate construction of a tambour shutter.

Waste-Wood Furniture Exhibit

A FURNITURE and building exhibition devoted exclusively to the application of Bartrev board took place recently at the Delmonico Hotel, New York, N. Y. Bartrev board is the product of the Bartrev continuous press, a machine that produces high-quality timber board by a continuous method. Although the board is not yet in production in America, presses are now under construction for use here (MECHANICAL ENGINEERING, August, 1953, page 654).

Bartrev Ltd., a British firm, is represented in North America by Aries Fiberboard Corporation, New York, N. Y.

The continuous, fully automatic operation of the Bartrev continuous press, it is claimed, will revolutionize existing concepts of the manufacture and utilization of chipboard. The Bartrev operation, reports indicate, will lower production costs and open up far wider fields for the use of this type of board.

The raw material for the press may be either waste or raw wood (or other fibrous material) which is converted by special machinery into particles of a suitable size. Once this raw material has been mixed with resins, the Bartrev continuous press converts the mixture into high-grade chipboard with only one fixed dimension, the 4-ft width, which expands design horizons further than have been visualized to date.

The board is normally produced in the usual commercial dimensions, 4 ft × 8 ft, but where the requirement for a special length exists, the purchaser can get the board in the exact length he desires. This eliminates the costly factor of waste.

Throughout the exhibit, emphasis was laid on how a contemporary material is suited to contemporary design and how in Bartrev Board lies the solution to less-

Fig. 3 This building is designed to have as little site work as possible. All external wall and partition panels are pressed Bartrev skins both sides of timber framing. The framing of the external wall panels supports the roof trusses while the partition panels can be moved to any position on any grid line (3 ft 6 in.) in the building, and are nonstructural. External panels can be supplied blank or with windows in various positions, also with heating panels built in. Internal partitions are either blank or with pass door. The system of construction allows any single panel to be removed and replaced without affecting the roof assembly.

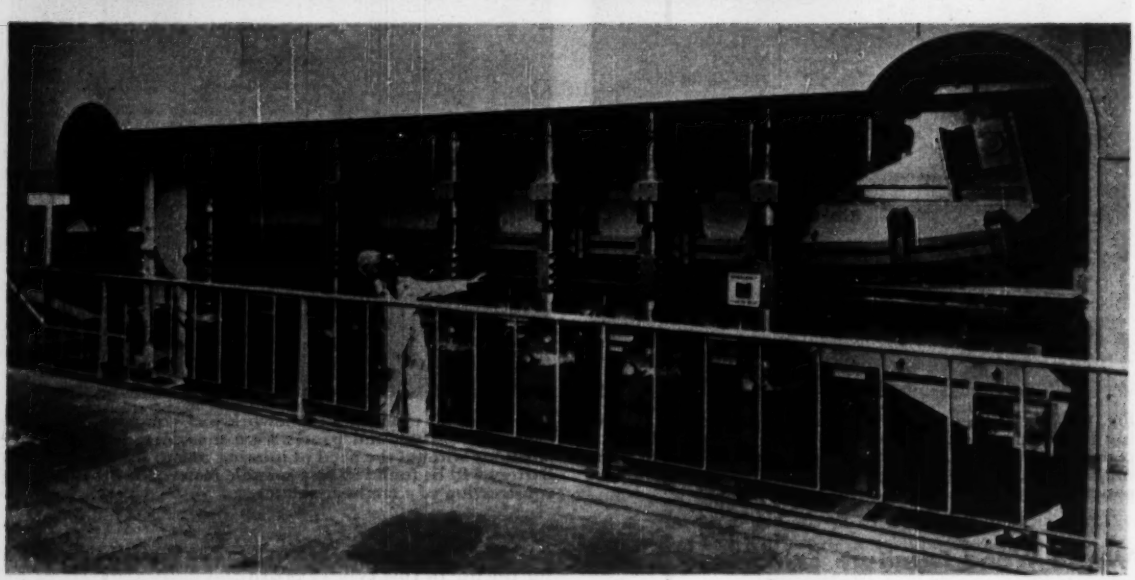


Fig. 4 Automatic Bartrev press for continuously converting wood waste and other fibrous materials into wood panels

expensive but better-designed products and buildings. The board can be used for roofing, ceilings, floors, and partitions. Again, the great advantage of buying Bartrev Board is in buying material in one piece, no matter what length is specified.

To the furniture industry, Bartrev offers a low-priced alternative to plywood as a core material of high quality, with many advantages in physical properties.

All veneers in the exhibition were applied to Bartrev Board as a core material without cross banding. This is of the greatest cost significance to the furniture industry.

The section of the exhibit devoted to shop and store fittings showed Bartrev to be a low-cost alternative to ordinary $^3/_4$-in. coreboard and showed its unique adaptability for prestige store design.

Another part of the exhibit demonstrated the attractive appearance and versatility of Bartrev board, making it particularly suitable for office furniture of all types. Desks, filing cabinets, and shelving confirm how this board material can be used to form rigid stable structures without the need of any timber framing.

Bartrev board, it was pointed out, should be considered equally as a material for furniture and as a building component. In modern building planning where the floor and ceilings do not rely on cross walls for support,

storage walls are planned between rooms and these are usually free standing for flexibility.

In a wall storage unit, Bartrev is used on studding, making a partition wall as a backing to the storage unit with a high degree of thermal and acoustic insulation. The storage unit is built on to this partition slab and veneered or paper-faced as necessary. A projecting shelf serves the dual purpose of a one-sided table or dressing table used in conjunction with a full-length-mirrored door of the wardrobe.

Three sections of a prefabricated building were shown using Bartrev for walls, ceilings, floors, and partitions. A building consisting of 26 similar sections has been erected in England at the plant where the board is produced. The roofing of the building gives a good example of the advantage of Bartrev board in unlimited length. These boards come from the press in 10-ft 6-in. lengths covering three sections of the building, thereby avoiding any cutting work.

The whole building is so designed as to reduce erection costs to a minimum. All wall panels, ceilings, and floor panels and trusses are delivered complete with veneering and treated with a weatherproof finish.

Plastic Pipe

INDUSTRY-WIDE interest on the possibilities of future use of plastic pipe by municipalities has been focused recently on the purchase by the City of Los Angeles Department of Water and Power of polyester resin, fiberglas reinforced plastic pipe manufactured by Reflin Company, Gardena, Calif.

The plastic pipe was selected by city engineers to replace standard steel-lined pipe when intensive surveys disclosed that Reflin's smooth seamless interior surface discourages attachment of mineral and biological deposits usually found in pipe lines. Unlike steel pipe, plastic will resist corrosion indefinitely, it is claimed. First use of the plastic pipe will be for condensate make-up lines in the new Valley Steam Generating Plant, now under construction on a 150-acre site in the San Fernando valley.

When completed in 1955, the $71 million Valley Steam

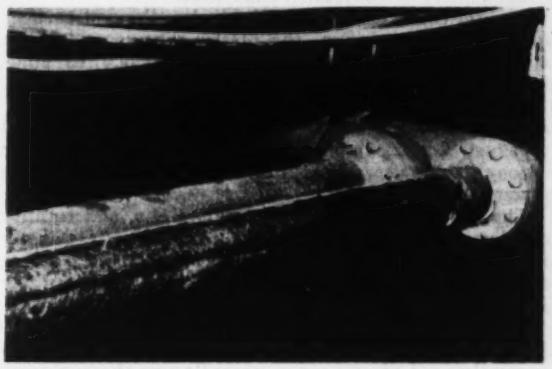


Fig. 6 Chemical-treatment drain line used in the Valley Steam Generating Plant. The pipe was made of 8-in. polyester resin, fiberglas reinforced plastic pipe. The pipe's smooth, seamless interior discourages attachment of mineral and biological deposits.

Fig. 5 These Los Angeles Department of Water and Power 10-in. condensate make-up lines are part of the Department's new Valley Steam Generating Plant. The lines are made of polyester resin, fiberglas reinforced plastic pipe.

Fig. 7 Plastic pipe is stored in this yard prior to use. The Valley Steam Generating Plant will be one of the largest in the west when completed in 1955 and will increase the city's power generation by 50 per cent.

Plant will be one of the largest in the west, increasing the city's present power generation by 50 per cent. Its eventual capacity of more than 512,000 kw is approximately equal to the total energy now available in Los Angeles from Hoover Dam.

The steam plant is tentatively composed of four units, each operating as an independent power plant and consisting of a steam generator, electrical generator, turbine, and a set of auxiliaries. Boilers with a steam-generator capacity of 850,000 lb per hr supply steam to each turbine. The plant is designed to withstand earthquakes and extreme weather conditions.

Lighter than steel pipe, easier to handle, and cheaper to install and maintain, the plastic pipe is said to be almost chemically inert with no tendency to cold-flow.

It is resistant to rust, chemical attack, electrolytic action, and other factors causing deterioration of steel pipe, say Reflin engineers. The company put the pipe through three years of research and development before placing it on the market.

The high impact strength, lightweight, and rigidity of plastic pipe allows unusual and ordinarily difficult installations to be made quickly and easily. Using standard fittings and simple tools, two men can lay Reflin pipe under average conditions.

With high allowable pressure and great resistance to head and impact loads the pipe is greatly improved over currently used plastic pipes, according to the company. Reflin pipe is adaptable to all standard auxiliary equipment, including valves, pumps, and tanks.

While envisioning a great future for plastic pipe in municipal use, the company sees many uses for their new pipe in other fields as well. The Tidewater Associated Oil Company uses Reflin pipe for salt-water disposal in its Ventura, Calif., oil fields. Union Oil Company has found it effective for corrosion service transmission over evaporation ponds. Standard Oil Company and Signal Oil and Gas Company use the plastic pipe in casings, line pipe, and transmission of chemicals.

Reinforced-Plastic Truck Trailer

A REFRIGERATED truck trailer, which through use of reinforced-plastic structural beams and panels, effects a 20 per cent saving in weight and a gain of 150 cu ft of pay-load space, was introduced at the recent American Trucking Association convention by the Strick Company of Philadelphia, Pa.

The new trailer, which will hold refrigeration at zero, is 35 ft long and equipped with a sliding tandem-wheel assembly and yet weighs only 11,800 lb—including its refrigeration unit. Its interior lining, structural beams, rear doors, rear-door frame, and a reflector pan covering the underside are all made from Lamicor—molded units of Vibrin, a polyester resin produced by the Naugatuck Chemical Division, United States Rubber Company, reinforced with glass fibers.

Lamicor, made and developed by Strick Plastics Company, an affiliate, is said to be stronger than steel on a pound-for-pound basis, corrosion-resistant, easily cleaned, sanitary, and has high thermal insulating qualities.

The trailer is also intended to be used as a general cargo hauler.

Major feature of the new trailer is the use of reinforced plastics for structural beams, instead of the conventional aluminum or steel. The plastic has an insulating factor, allowing the beams to be used as part of the insulation. This steps up the efficiency of the trailer's insulation because all metal-to-metal contact is eliminated. It also eliminates the need for unsanitary wooden stringers and makes the high cubic-capacity design possible.

Fig. 8 A reinforced plastic beam used in the underbody of new refrigerated truck trailer is examined by C. Bradford Sheppard, president of the Strick Company, Philadelphia, Pa.

The understructure of the trailer is made from 6-in., plastic beams, set on 12-in. centers. A plastic reflector pan, running the full length of the trailer, is attached to the bottom edge of the beam. This pan allows 6 in. of insulating material to be placed between the floor beams.

This new understructure design, a departure from conventional refrigerated trailers in which the insulation is placed above the floor beams, adds 125 cu ft to the trailer's capacity. An aluminum floor, corrugated for air circulation, is attached to the upper edge of the beams.

Plastic beams, 4 in. deep with insulating material placed between them, are used in the sides and roof. This adds another 25 cu ft to the trailer's cargo space. This amount of insulation, plus the floor insulation, also permits the trailer to hold 0 F refrigeration, which is sufficient for any cargo requiring refrigeration.

Molded panels of reinforced plastic are also used for the interior liner. They are said to be ten times stronger than the plywood liner generally used, and can be cleaned almost as easily as glass. In addition, they will not warp, pick up odors, or corrode. They are corrugated to permit air circulation and impregnated with white coloring for cleanliness.

The rear doors and door frame of the trailer are also molded from reinforced plastic. This use of plastic, which will not shrink or warp, insures a tight seal that will not be affected by adverse weather conditions.

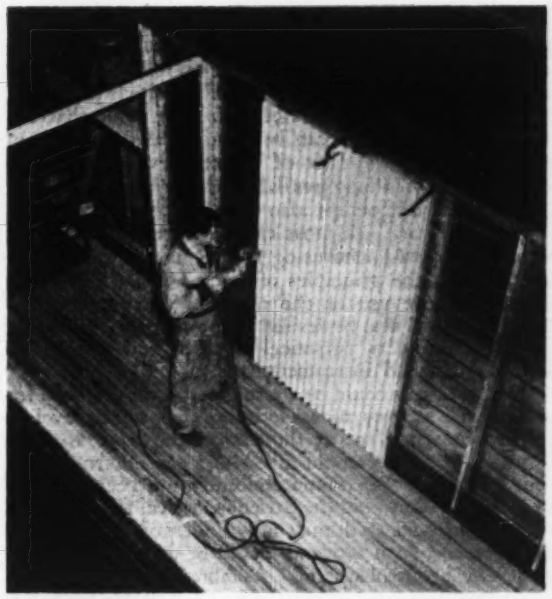


Fig. 9 Ribbed panels of reinforced plastic are shown being attached to 35-ft refrigerated truck trailer during construction. The beams to which the panels are attached are also plastic.

All of the plastic parts in the new trailer are riveted together, just as conventional metal trailers are assembled. This makes it easier to repair the trailer if necessary.

Air-Pollution Bibliography

AVAILABLE scientific literature on outdoor air pollution is summarized in an exhaustive bibliography compiled from foreign and domestic sources by the Bureau of Mines and released recently by the Department of the Interior.

The publication was prepared at the request of the chairman of the United States Technical Conference on Air Pollution, held at Washington, D. C., in May, 1950. It contains more than 3900 references dating from 1819 to 1952.

Polluted air, the bulletin says, has been troubling mankind for centuries. It may cause damage to his health, to his forests and crops, and even to his buildings. With the great industrial development it has become in many instances an all-important problem and, according to the American Municipal Association, only four United States cities with populations over 25,000 have not established some sort of control. Up to $120 million a year reportedly is spent to combat air pollution throughout the nation.

The bibliography lists references under such subjects as: General aspects of air pollution; nature and origin; composition of pollutants; effects on health, materials and structures, and vegetation; methods of determination and control; legal aspects of the problem; and costs in damage by air pollution. Abstracts under each subject are in chronological order, arranged alphabetically by authors. An index of authors is included.

Bureau of Mines Bulletin 537, "Air Pollution, A Bibliography," by S. J. Davenport and G. G. Morgis, can be obtained only from the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., for $1.75 a copy. This bulletin is not for sale by the Bureau of Mines.

Submarine Telephone Cable

THE first submarine telephone cable between the United States and Europe is expected to be in commercial operation by late 1956, four top-ranking British and American communications experts announced in a paper presented before the 1954 fall meeting of the American Institute of Electrical Engineers, in Chicago, Ill.

The new $35 million transatlantic telephone system will be by far the longest underseas voice cable in the world and the first laid at depths found in mid-ocean. It will supplement radio circuits now in use and will have three times the present circuit capacity.

The paper was authored by Dr. Mervin J. Kelly, president of Bell Telephone Laboratories, who presented the paper; Sir Gordon Radley, deputy director general of the British Post Office; George W. Gilman, Bell Laboratories director of systems engineering; and R. J. Halsey, assistant engineer in chief of the British Post Office. The cable will be owned jointly by the American Telephone and Telegraph Company, the Eastern Telephone and Telegraph Company, the British Post Office, and the Canadian Overseas Telecommunications Corporation.

2000 Nautical Miles Long

The transatlantic portion of the system to provide 36 high-grade telephone circuits between the United Kingdom, Canada, and the United States, will be 2000 nautical miles in length. It will be laid in depths up to three miles on the ocean floor between Scotland and Newfoundland and each of the two cables will contain 52 submerged repeaters. The longest submarine telephone cable now in use is less than 200 miles long and no cable contains more than four repeaters.

The system will contain a group of telephone circuits between New York and London and another group between Montreal and London. At the gateway cities, the circuits will connect with the telephone systems of the respective countries.

Telephone conversations from the U. S. will be carried overland by a microwave radio-relay from Portland, Maine, to Nova Scotia where the radio-relay route will connect with a 300-mile submarine cable to Newfoundland. The transatlantic portion of the cable will stretch from Clarenville, Newfoundland, to Oban, Scotland. The transatlantic circuits will be taken from Oban to London by carrier cable with alternative routes via Glasgow or Inverness and Aberdeen. In London, it will be possible to connect any transatlantic circuit to any one of the existing submarine cable circuits to the continent of Europe.

Coaxial-Type Cable

The new transoceanic cable will be of the coaxial type consisting essentially of a copper tube, through the center of which runs a single copper conductor, properly insulated from the surrounding outer conductor. High-molecular-weight polyethylene is used for insulation.

The cables will be not quite two thirds of an inch

in diameter at the outer conductor. They will be protected against the teredo worm, a marine borer, by wrappings of copper tape. Outside this will be wrappings of heavy jute, steel-armor wires for mechanical strength, and an outer wrapping of jute to prevent corrosion of the armor wires. The deep-sea sections will be about $1^1/_4$ in. in over-all diameter.

Repeaters, with their electron tubes and many other associated parts, appear simply as bulges in the cables. This will permit them to be fed smoothly around the drums and sheaves of the cable ship "*Monarch*" so that the cable and repeaters can be laid on the ocean floor as a continuous operation.

Each repeater, spaced about 40 miles apart, will consist essentially of a three-stage feedback amplifier, so that there will be more than 300 long-life electron tubes on the ocean floor with some 6000 other electrical components, all designed for reliable, trouble-free operation for 20 years or more.

Electron tubes and other components, constructed or selected for reliability in service, have been under life test since 1940.

Electrical power to operate the amplifiers will be fed to them over the central conductor of each cable from the terminal stations on shore. This will require more than 2000 volts at each end. The design of the terminal power plant will place special emphasis on current regulation, continuity of service, and protection against power surges.

Dr. Kelly commented on the difficulties yet to be encountered in actually laying the cable. A period of 12 days with continuously good weather conditions is necessary to carry out the main operation. In the North Atlantic such conditions are unlikely except during the period mid-May to mid-September. One cable will be laid during the summer of 1955 and all cable-laying operations are scheduled to be completed in 1956.

Packaged Power Reactor

THE present efforts of the Nuclear Engineering Section of the American Machine & Foundry Company are being directed toward development of the packaged reactor for easier use and more economical power, according to Chris J. Brous of AMF. He spoke before the National Industrial Conference Board's Third Annual Conference on "Atomic Energy in Industry," recently. The packaged reactor offers less complex and easier to use nuclear-reactor components and systems. AMF, he said, is initiating the development of designs of major assemblies and components which can be integrated into different nuclear-reactor systems. The availability of reactor systems designed and built with these principles, using packaged or building blocks, will lead to easier acceptance of the nuclear reactor for power and research. The operation and maintenance of a reactor facility should be simplified because the user will have acquaintance with similar packaged units.

In order to satisfy the many needs and applications of this type of power plant, packaged units will have to be developed which are available in several capacities and arrangements, Mr. Brous said. In addition, to obtain higher capacities, duplex units probably will be used. These are similar to the modern use of single and multiple diesel-generator units in small power installations.

A typical use for a packaged power reactor is at a possible remote mine installation. Imagine a site located in a rugged, mountainous region, with just a few rough roads and no railroads. The site is known to be rich in mineral deposits of such high value that the ore or refined product can be economically flown from the site. Only the lack of power prevents these resources from becoming available to world markets.

The packaged concept also finds ready application to research reactors. In most cases, where a research reactor is proposed, the using facility is not specifically interested in the principles of reactor design but is interested in the use of the neutrons for experiments. Possibly it will also be desired to use this type of reactor for the training of personnel in the principles of reactor control and instrumentation.

Typical of this could be a research reactor designed for medical use. Tests today indicate that a flux level of 10^9 neutrons/cm^2/sec at the patient exposure aperture is desirable. This would give short patient irradiation time during the maximum concentration period of the irradiation material in the patient's critical tissue area.

From the packaged units now undergoing design and development, such a reactor could be assembled having a simplified control system. As more data are developed by medical personnel, it may be found desirable to change the flux conditions or the control conditions for better patient exposure. With packaged units, easy removal, rearrangement, and possible substitution of control, fuel, and reflector components to provide for the new conditions could be made.

The need for a small nuclear power plant exists in the U. S. as well as in many parts of the world. According to Mr. Brous, the small power unit can bring power into those parts of the world heretofore thought to be extremely difficult, if not impossible, to develop.

Mobile Electric Power Plant

A NEW type of mobile diesel-electric power-generating plant designed to help utilities to meet difficult problems in public service growing out of the increasing migration of population and industry from populous centers to far outlying territory, has been developed by Electro-Motive Division of General Motors at La Grange, Ill. For example, the units are said to be capable of meeting unusual demands for current which are either so seasonal, so temporary, or so low in load factor that it is not economic to extend either an original power line or a second line for protection.

Five models of the "Electro-Mobile Power Units" were disclosed. Three are designed to be moved over railroads and two for movement over highways. The railroad units are of 500, 750, and 1000-kw capacity.

The highway units are of 350 and 500-kw capacity. The units may be as rapidly coupled together as the units of a standard diesel locomotive so any desired capacity may be obtained from a single 350-kw highway unit or 500-kw rail unit to whole highway fleets or long trains of railroad units totaling, for instance, 100,000 kw or whatever is necessary to put an average American city back into operation after a disaster of war or nature.

Pilot models of the 500-kw highway unit and of the 1000-kw railroad unit will be loaned to utilities for tryouts on local problems on a coast-to-coast tour.

Also introduced were four models of a new portable generating plant utilizing the same General Motors 567C diesel engine and other major components used in the mobile plants. The portable plants, on skids and capable of being put on railroad cars or truck trailers for transport, are designed for more permanent installations than the mobile plants. They are 350, 500, 750, and 1000-kw capacity.

Major components of the new machines (such as diesel engines) are either already in production for use in General Motors locomotives, or are so closely related to other standard major components of diesel locomotives (such as generators and car structures) that existing production machinery, methods, and labor at La Grange can be immediately switched to the new product, it was explained.

A new line of "A" series generators has been designed to withstand a 25 per cent overload and to operate at 4160 or 2400 volts. Utilizing silicone, glass, and mica, these generators have improved insulation better fitted than any other known insulation to withstand the intermittent operation in varying weather conditions frequently found in fringe-area, low-load factor situations.

An outstanding feature of the electro-mobile units is availability of automatic-control apparatus which makes these units completely self-operating at far outlying points. They can be controlled by a central operator, hundreds of miles away, by impulses over a wire, or by radio, or they can be started or stopped by fluctuations in voltage on the line which they are serving.

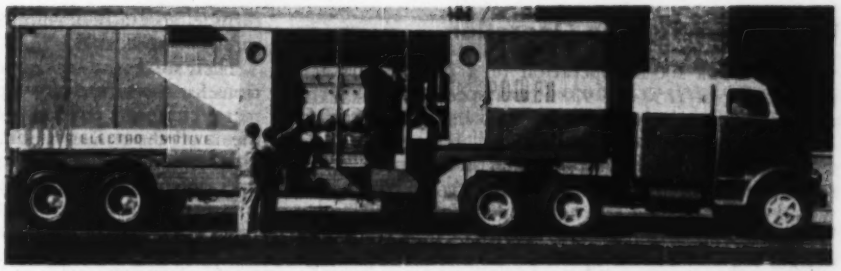


Fig. 10 New 500-kw capacity "Electro-Mobile" diesel-electric generating unit, designed and built by the Electro-Motive Division of General Motors Corporation, La Grange, Ill., to help utility companies protect and improve service to homes and industries in far outlying areas and to meet emergency conditions. Doors are open to show prime mover—800-hp General Motors 567C series diesel engine. Four other portable generating plant models, of 350, 500, 750, and 1000 kw, were also introduced.

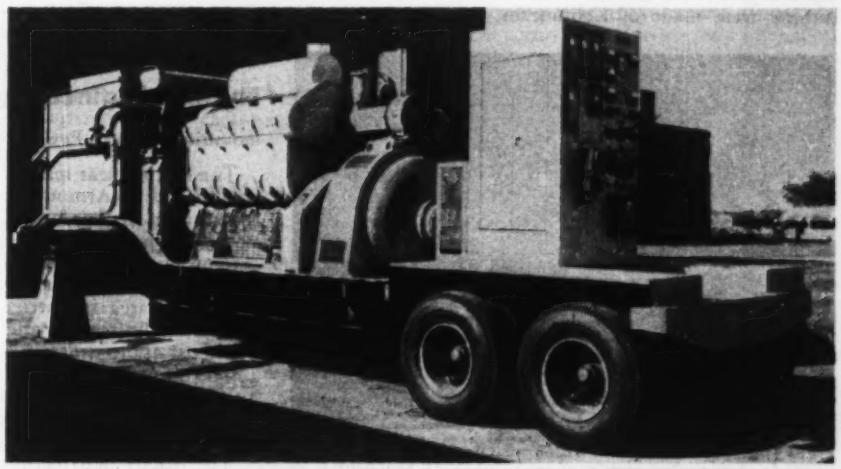


Fig. 11 View of Electro-Mobile 500-kw diesel-powered electric generating unit for transport on highways without car body, showing arrangement of principal components. Shown from *right* to *left* are switchgear cabinet, new high-efficiency alternating-current generator, 800-hp diesel engine, and cooling system.

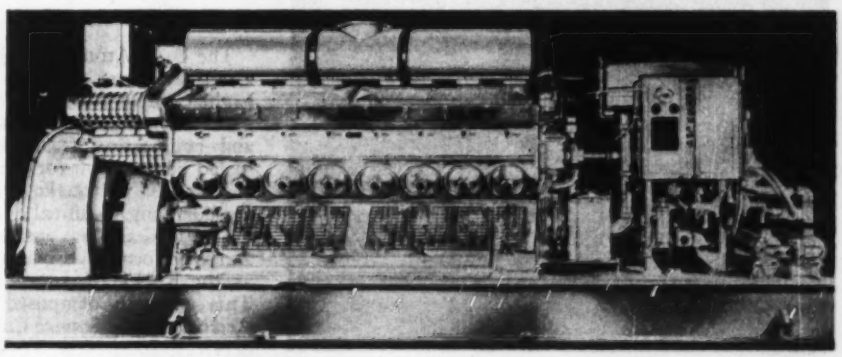


Fig. 12 New 1000-kw diesel-powered portable electric-generating plant, designed to assist utility companies in protecting and improving electric service to homes and industries in far outlying or fringe areas and for use as emergency stand-by equipment. This unit, mounted on a rigid steel platform, can easily be transported on skids by railroad cars or truck trailers for use at semipermanent or long-term locations. Similar units can also be supplied in 350, 500, and 750-kw capacity.

100-Hr Gas-Turbine Operation

CONTINUOUS 100-hr operation of a gas turbine at a temperature of 1850 to 1900 F and speed of 30,000 rpm was revealed recently by Kennametal Inc., Latrobe, Pa.

Using its own specially designed and operated test turbine, Kennametal subjected the turbine parts to the same conditions of temperature and stress which they would encounter in a jet engine operating at full power. This unit also permitted the testing of new component designs required for the optimum use of their super high-temperature carbide, Kentanium.

Engineers found little change in the critical parts of the turbine, particularly in the impeller, which is its one moving part. Ordinarily, gas turbines can withstand operating temperatures in the range of only 1400 to 1600 F, which greatly limits their power and efficiency.

Key to the successful test, according to company metallurgists, was the fact that the critical parts of the turbine were made of Kentanium, a sintered titanium carbide, specially developed to withstand high temperatures and speeds.

Their successful results were seen having great implications for the future of gas-turbine power plants. Kennametal engineers envision the day when further development of these Kentanium materials made by modern powder-metallurgy techniques will enable gas turbines to operate at temperatures well in excess of 2000 F.

It was also revealed that the fuel efficiency of gas turbines could thus be improved 50 to 100 per cent or more.

Explaining further the significance of the already attained 30,000 rpm at high temperatures in their test gas turbine, Kennametal engineers said that an automotive unit, such as a truck power plant, would operate only a small portion of the time at full power output so that this 100-hr performance of the Kennametal turbine would correspond to thousands of hours of truck operation.

The Kennamental tests were based on the fact that the power and efficiency of gas turbines is greatly affected by the temperatures at which they operate.

Fig. 13 Experimental gas turbine which could lay the groundwork for increasing power of jet engines 50 per cent is inspected by Philip M. McKenna, Mem. ASME, president of Kennametal Inc., *left*, and John C. Redmond, vice-president and director of research and development, at the company's Kingston Station, Pa., plant.

Fig. 14 Close-up of impeller in experimental gas turbine developed to test super high-temperature alloy, Kentanium. Using Kentanium in critical parts of the gas turbine, the turbine was operated continuously for 100 hr at a temperature of 1850 to 1900 F and speed of 30,000 rpm. No change in the parts was apparent.

Nuclear-Engineering Briefs . . .

Industrial Research Reactor

THE first nuclear reactor for industrial research will be established at Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill. Plans for the reactor—or atomic pile—are being submitted to the Atomic Energy Commission for consideration of the design, building plans, and schedule of operation.

Chicago-area industries will join the Foundation in financing the reactor and associated equipment, which will cost approximately $500,000.

The proposed reactor, designed for 50,000 watts, is specifically a highly flexible neutron and gamma source, and is not intended for research on reactors themselves or for the generation of electrical power.

The reactor will permit investigation into such fields as: Sterilization of foods and drugs; high-polymer studies of the structure of plastics, rubber, and similar materials; glass and ceramics; wear and friction studies; the development of metals and alloys, and medical techniques for diagnoses and therapy.

Power-Reactor Studies

The U. S. Atomic Energy Commission has authorized a nuclear-power study by the Pennsylvania Power and Light Company of Allentown, Pa. The Company will make a detailed study at its own expense of the economic and engineering feasibility of a large-scale, nuclear-fueled power plant for use in its own system.

The AEC will make available to cleared personnel of the company technical data on reactor development.

The AEC also has authorized a nuclear-power study by a newly formed association of nine companies known as the Rocky Mountain Nuclear Power Study Group. This group is composed of the following companies: Arizona Public Service Company, Phoenix, Ariz.; Ebasco Services, Inc., New York, N. Y.; Fluor Corporation, Ltd., Los Angeles, Calif.; Idaho Power Company, Boise, Idaho; Minnesota Mining and Manufacturing Company, St. Paul, Minn.; Phillips Petroleum Company, Bartlesville, Okla.; Public Service Company of Colorado, Denver, Colo.; Riley Stoker Company, Worcester,

Mass.; and Utah Power and Light Company, Salt Lake City, Utah.

The group will study at its own expense the economic and engineering possibility of a nuclear power reactor for the western United States. It will first study the feasibility of a reactor, cooled and moderated by light water, fueled with slightly enriched uranium, and designed for the purpose of producing both power and fissionable material. The group will then investigate the economic feasibility of other reactor types.

Nuclear Ship Propulsion

Two projects for the development of nuclear propulsion for large naval vessels were announced by AEC recently. Research and development work on a reactor suitable for large ship propulsion has been assigned to Westinghouse Electric Corporation and $1,250,000 authorized for this work for the current fiscal year.

Separate design studies of large nuclear-powered ships recently have been undertaken by the Newport News Shipbuilding and Dry Dock Company at Newport News, Va., and the Bethlehem Steel Company, at Quincy, Mass., both under contract with the Bureau of Ships, Department of Navy. The pressurized-water reactor type has been selected for this project.

Boiling-Water Reactor

Argonne National Laboratory, operated for the U. S. Atomic Energy Commission by the University, of Chicago, has announced that Sargent and Lundy Ghicago, Ill., has been selected as the architect-engineer for the design of the experimental boiling-water reactor which has been authorized as part of the Commission's five-year program for development of competitive electrical power from nuclear fuel. Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been chosen to design, develop, construct, and install the power generation, heat transfer, and special equipment for the power cycle.

The experimental boiling-water reactor (EBWR) which will be built on the Argonne site in DuPage County, Ill., will produce 20,000 kw of heat and 5000 kw of electricity. The reactor will use slightly enriched uranium fuel and will be moderated and cooled by ordinary water. Construction is to start in 1955.

Nuclear Research Facilities

Plans for building the Karl Taylor Compton Laboratories for Nuclear Science and Electronics as the Massachusetts Institute of Technology's memorial to the Institute's late chairman, Dr. Karl Taylor Compton, were announced recently.

Preliminary drawings for a $3 million building are already completed. In addition, a fund of $3 million will be provided for unrestricted support of the Institute's work in these fields.

M.I.T's nuclear reactor, to be devoted solely to education and nonsecret research in the peacetime applications of nuclear power, will also be associated with the Karl Taylor Compton Laboratories.

Plans for a $1,535,000 expansion of its nuclear-energy research facilities also have been announced by Battelle Institute, Columbus, Ohio. The new facilities will be used for enlargement of the Institute's contract research for industry and government in the atomic-energy field. They are in addition to present facilities available for nuclear research, in which the Institute has $2 million invested.

All funds for the expansion program already have been appropriated by the Institute's board of trustees. Construction of a nuclear reactor, a reactor-development laboratory, and a nuclear-fuels laboratory is scheduled to begin shortly. Plans also call for the installation of a large cobalt-60 source.

Theory of Maintenance of Rolling Stock

(*Continued from page 1000*)

railroad hopper car depends upon the life of various components, some having long lives and some relatively short lives. The car may become unserviceable (i.e., fail) if the journals fail or a wheel is fractured or if the sides become so corroded that they cannot retain the cargo. Each of these components has its own life curve, each different from the other two. This situation is more complicated than the preceding cases but is still amenable to analytical techniques. A complete discussion of this problem will not be given here but a few remarks may be of interest.

For illustrative purposes, let us assume that curve A in Fig. 5 is for journals, curve B for wheels, and curve C

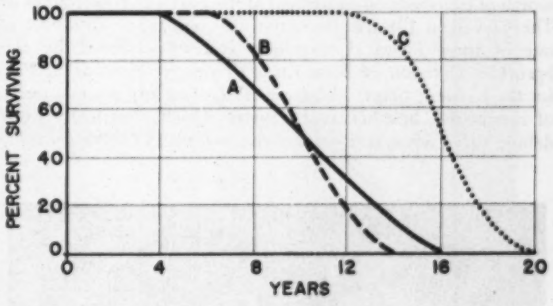
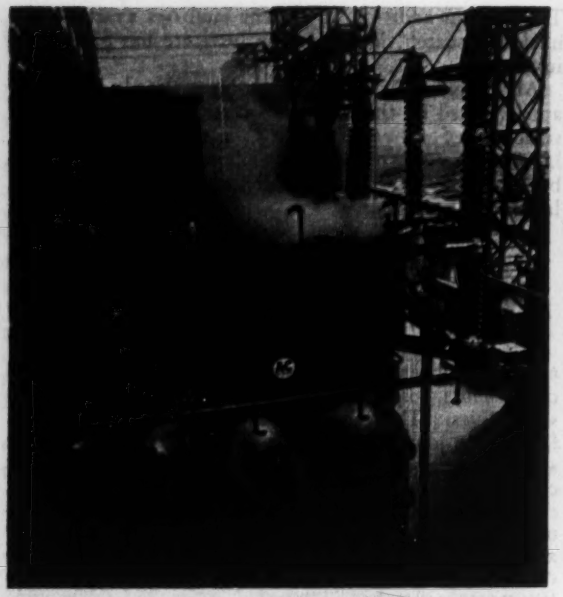


Fig. 5 Life curves for three components of a system

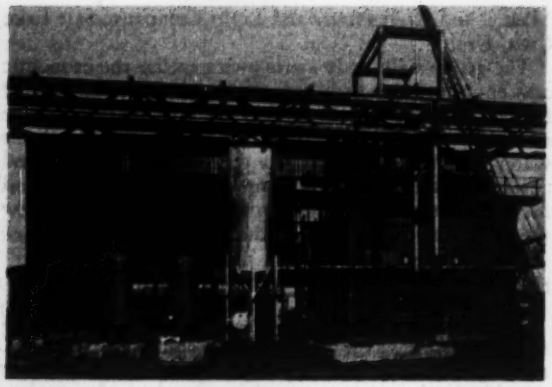
for the hopper sides, and let us assume that these are the only three components in the hopper.

The curves in Fig. 5 indicate that in this illustration there is no chance of a wear-out failure for the first four years after a new hopper is put into service. After that there is a gradually increasing chance of failure in the journals, then in the wheels, and after 12 years, in the sides. Owing to the variations in the lives of these components, one cannot predict, for example, that the journal will fail before the wheel fails; in many cases the journal could outlast the wheels. Similarly, there are some journals which could last longer than some car sides. The question arises as to the best way to program the replacement and repair of these parts.

A gain sometimes may be achieved by the replacement of two or more components with different life curves at the same time. This reduces the time lost by the car and leads to other savings, such as decreased parts inventory and labor, resulting from combining the two operations. Against this saving, of course, must be balanced any loss in the useful life of one or more of the replaced components.



Water-Fog System. More than 2200 gpm of water shower from 90 nozzles in a test operation to check the efficiency of this water-fog system. The system guards more than $500,000 worth of transmission equipment at the Eastlake power plant of The Cleveland Electric Illuminating Company. This unit is one of three identical water-fog systems designed by the Sprinkler Division of Blaw-Knox Company, Pittsburgh, Pa., for the Eastlake plant. Water is released by any one of a series of rate-of-rise heat-actuated devices which electrically open deluge valve when temperature rise is from 15 to 20 F per min.

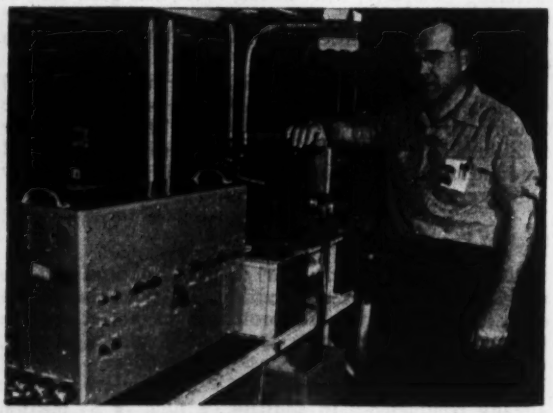


Tonnage Oxygen Plant. This large tonnage oxygen plant is being erected by Chemical Plants Division, Blaw-Knox Company, Pittsburgh, Pa., for the McLouth Steel Corporation at Trenton, Mich. The plant will be the first Linde-Fraenkl cycle-type process to produce high-purity oxygen in this country. Blaw-Knox Company is the United States supplier for the process. Crude argon is also produced in this installation. Blaw-Knox is designing and constructing a companion plant for argon purification.

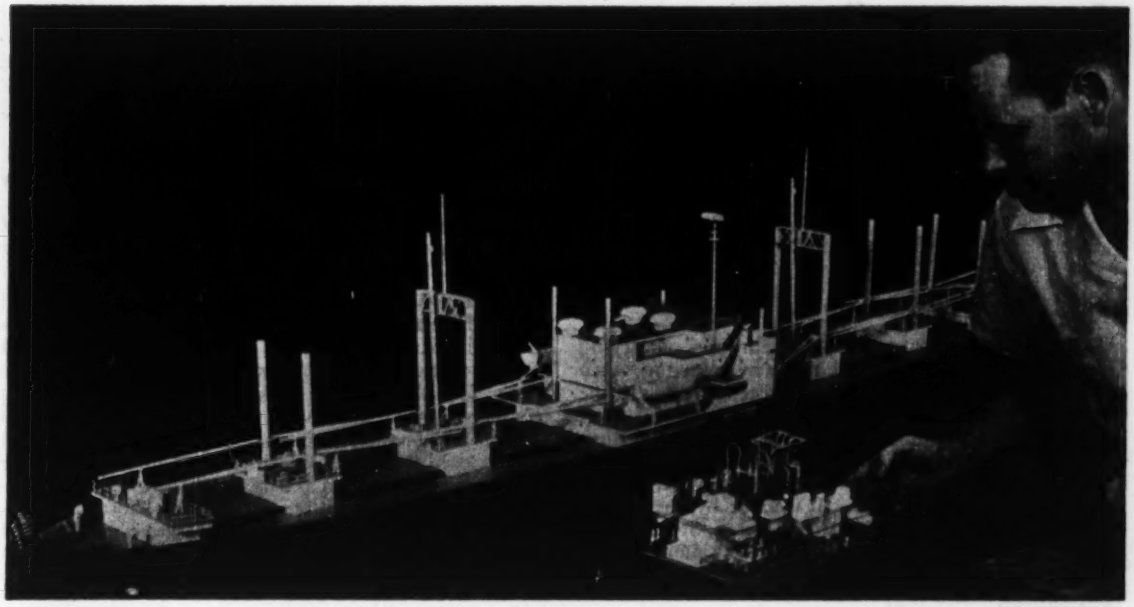
Engineering Developments

. . . at a glance

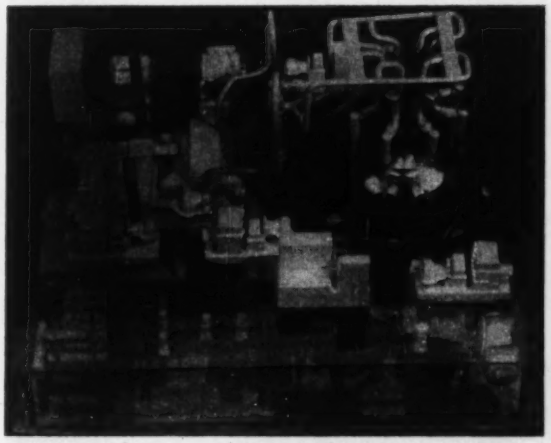
Spot-Welder's Aid. Unwieldy, multicontoured aircraft assemblies have been troublesome problems for spot-welding machine or riveting machine operators. Some assemblies required two or more men to hold them during operation. To achieve faster production at reduced labor cost, Martin Aircraft, Baltimore, Md., has developed a handling rig that suspends an assembly part at its center of gravity. In this position the part is completely free swinging and easily handled by one man. Small parts are hung from an overhead crane; large parts are mounted at their center of gravity on an arm which is built out from the base of the machine.



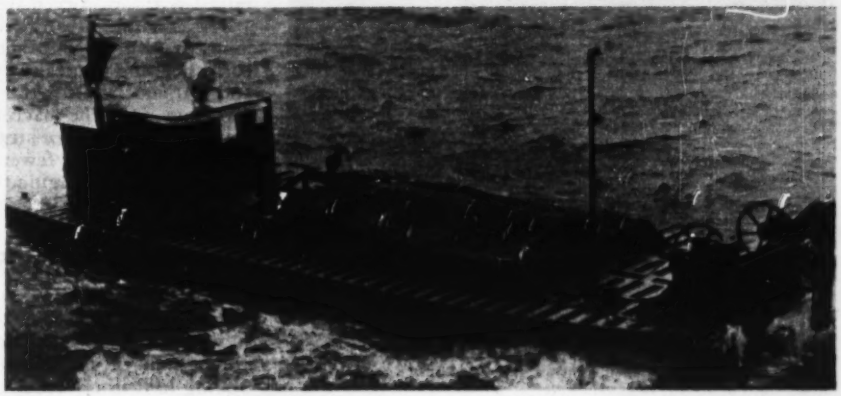
Cutting, Stamping, and Measuring Machine. An electronic, push-button machine which cuts, stamps, and measures electric wire in one operation has been developed and put into service by Douglas Aircraft Company, Santa Monica, Calif. It was designed and developed by Glen Lydolph of Douglas. His compact device—which eliminates five manual operations—cuts, counts, and stamps identification numbers on insulated electric wire in one operation. Eight of the machines already are employed in the production of DC-6/7 type transports and missiles at the Santa Monica plant. Another nine of the devices are under construction for use in other divisions.



Atomic Ship Model. A scale model, *above*, showing the application of nuclear power for propulsion of a cargo vessel, has been built by the Newport News Shipbuilding and Dry Dock Company, at the request of the United States Information Agency. The model is a replica of the latest and fastest type of cargo vessel, the 560-ft, 20-knot Mariner Class. With the use of atomic power, such a ship could stay at sea for years without refueling. Instead of a firebox and boiler, the ship's atomic-power plant would have a reactor which would generate heat and change water into steam. Machinery such as steam turbines, pumps, condensers, etc., would be the equivalent of those on a normal ship. The engine and boiler rooms on the atomic-propelled ship would require about the same space as those of a normal ship. However, some additional cargo space would be created by elimination of fuel-oil tanks within the ballasting requirements of the ship. The outstanding difference in the appearance of an atomic-powered vessel would be the absence of a smokestack. Nuclear power would create no smoke or soot. Close-up view of the model of the atomic ship-propulsion unit is at *right*. Atomic reactor is at *right rear*.



Plastic Barge. A flat-bottomed self-propelled plastic craft for use on shallow inland waterways overseas has been designed by E. R. Chance & Associates, Arlington, Va., in cooperation with the Transportation Research and Development Command of the Army Transportation Corps. The vessel, weighing only 10.2 tons, can transport five tons of dry cargo with a draft of only 21 in. when loaded, and has a maximum cargo capacity of 10 tons in deeper water. The 50-ft craft is powered by two 165-hp General Motors diesel engines.



European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] Mem. ASME, *European Correspondent*

Rapid Precision-Swaging Machine

THE production from bar stock of forgings of varying diameter may be accomplished either by upsetting, when the diameter is increased locally to more than that of the stock, or by swaging, which reduces the diameter locally. The de Roll precision-forging machine illustrated in Fig. 1, which was shown in operation at the Fourth European Machine Tool Exhibition at Milan, Italy, uses the latter method. It is made by the Société des Usines de Louis de Roll S. A., of Berne, Switzerland, and is produced in three sizes, having maximum forging pressures of 60 tons, 100 tons, and 500 tons, respectively; the machine that was demonstrated was of the 100-ton size. The bar to be forged is gripped by an air-operated chuck, controlled by a pedal, and is rotated rapidly while being fed downward between the three swaging hammers. The hammers are arranged in the horizontal plane in the lower part of the body of the machine and are disposed equally at 120 deg in plan. They strike simultaneously, so that the forging blows are in equilibrium, and are mounted on the ends of short stiff connecting rods, guided throughout the stroke and actuated by vertical eccentric shafts which are driven through helical gearing by a 30-hp motor. The forging tools are oil-cooled and the connecting-rod guides are water-cooled to dissipate the heat conducted from the forging. The chuck is cooled by compressed air.

Fig. 1 de Roll 100-ton pressure precision-forging machine

The bearings of the eccentric shafts are mounted in rotatable housings which are also eccentric so that, by turning them, the radial distance of the hammers from the vertical axis of the machine can be varied at will, to suit different diameters of the work. The control mechanism which effects this is hydraulic and is actuated by stops on a drum, with the addition of a template if it is desired to forge tapers or other noncylindrical forms.

The control system also regulates the rate at which the stock is fed downward to the tools; thus the combination of the two motions, i.e., the downward feed of the work and the radial feed of the tools, determines the various diameters of the finished work and the lengths of the cylindrical portions of any given diameter. On the standard type of machine for round work, seven different lengths and diameters can be preset and are then forged as one automatic operation. Adjustable throttle valves enable the forging speed and the pauses in the axial movement to be regulated to insure the clean forging of steps. It is stated that a dimensional accuracy of ±0.02 mm (0.008 in.) on the diameter can be maintained with hot-forged steel pieces of 40 to 60 mm diam.

The machine illustrated will take work with a maximum diam of 60 mm and a length of 1000 mm. The corresponding figures for the 60-ton machine are 60 mm and 600 mm, and for the 500-ton machine, 250 mm and 5000 mm. On the machine demonstrated at Milan, the complete forging of a straightforward cylindrical workpiece with seven or fewer diameters took from 1 to 1½ min, including changing the piece.

High-Precision Automatic Lathes

SWITZERLAND was well represented at the Milan Exhibition, especially by the high-precision tools which have been developed there to a superlative degree for the production of minute components for watches. The sliding-headstock type of automatic lathe, which is

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

chiefly favored for this class of work where production in quantity is required, has been in use now for more than 70 years; but it is still in process of further refinement, as was evidenced by the "Isomatic" lathe exhibited by Andre Bechler, Ltd., of Moutier.

This machine, Fig. 2, has five radial tool slides in the headstock and an undercutting attachment with two inclinable tool slides, and can be fitted with a number of additional attachments which considerably increase its versatility. For instance, it can be provided with one, two, or three drilling spindles, threading attachments of various kinds, a three-spindle combined centering, drilling, reaming, threading, and tapping attachment, and equipment for slotting, cross-drilling, and back-

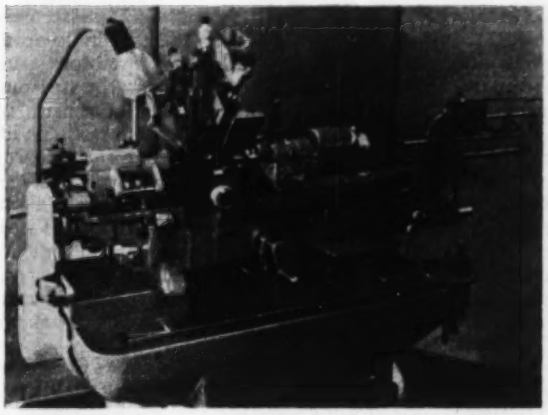


Fig. 2 Type AS-7 Isomatic high-precision automatic lathe with five radial tool slides and three spindle drilling attachments

counterboring. It is possible also to stop the rotation of the spindle in order to carry out such operations as milling, the drilling of eccentric bores, or the turning of eccentric pivots.

Various improvements in detail eliminate to a great extent the variations in accuracy which might be caused by changes in the ambient temperature or the thickness of lubricating-oil films. At every revolution of the camshaft the principal tools resume their initial positions with an accuracy of 0.1 μ (0.000004 in.), and the makers claim that, in continuous operation, it is possible to keep the dimensions of the finished products within the limits of $\pm$0.001 mm (0.00004 in.). The lathe's micrometer adjustment operates to this limit of accuracy, and in both directions, a light permanent loading being imposed on the micrometer spindle to eliminate all play.

Profile Grinding With a Pantograph

High-precision profile grinding is now usually associated with some form of control by optical comparator. The PSM 130 and PSM 250 profile grinders, exhibited by Fritz Studer A. G., Glockenthal-Thun, Switzerland, are believed to be unique in using a stylus working against a fixed template and controlling the movement of the grinding wheel by means of a pantograph.

An essential feature is that the section of the grinding wheel corresponds exactly to the form of the point of the

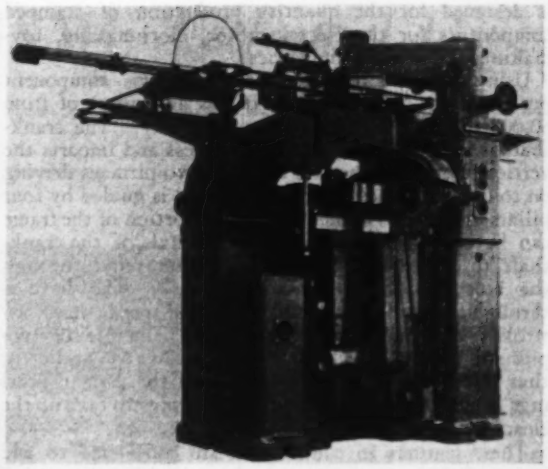


Fig. 3 Studer profile grinder showing pantograph gear

stylus, so that any path which the stylus may trace is precisely reproduced by the wheel. The movements of the stylus are transmitted to the wheel by the pantograph and a parallel motion, with a variable ratio that is adjustable at will; thus geometrically similar pieces of different sizes may be produced from a single template. As Fig. 3 shows, the pantograph with its linkage is well above the grinding position and does not interfere with the operator's control of the machine.

High-Speed Press With Underdrive

The German machine-tool industry occupied the largest number of stands at the Milan Exhibition—nearly 300 in all—and well maintained its standards of design, accuracy, and finish. One of the longest-established of the German exhibitors, L. Schuler A.G., of Göppingen, Württemberg, showed, among other tools, the high-speed underdriven press, Fig. 4, which

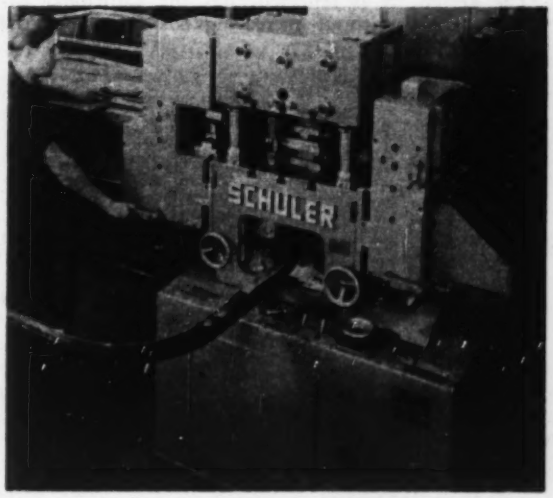


Fig. 4 Schuler high-speed press equipped with underdrive

is designed for the quantity production of stamped components for the electric-motor, clockmaking, toy-making, and similar industries.

Using a single tool and producing one component per stroke from strip stock, it has an output of from 60,000 to 100,000 parts per working day. The crankshaft is located in the base of the press and imparts the vertical motion to the ram through two pitmans driving on to opposite sides of the ram, which is guided by four pillars in the press frame. The upper portion of the frame can be canted backward about the axis of the crankshaft to allow stampings which cannot fall through the bolster to slide out to the back. The drive is through an infinitely variable gear, and speeds up to 500 strokes a minute can be attained. The use of two pitmans insures that the ram face is always parallel to that of the table, and lost motion in the pitman bearings is minimized by fitting strong springs to take up the clearance.

These features in conjunction are considered to add at least 25 per cent to the working life of the tools by restricting the penetration of the punch into the die.

Another cause of tool wear is the production of incomplete stampings, which results if the length of the strip that is being fed into the press is not an exact multiple of the feed. This is obviated by fitting a device which trims the strip at the beginning and end to the precise length required. A scrap shear is mounted behind the out-feed rollers and can be set to act either after every stroke or after any desired number of strokes, to cut up the scrap into convenient lengths for baling. It also can be thrown out of action when toolsetting, so that the operator can judge from the pierced strip that the setting is correct.

Heavy-Duty Lathe With Inclined Bed

The lathe shown in Fig. 5, which was exhibited by the Vereinigte Osterreichische Eisen- und Stahlwerke, of Linz-Donau, Austria, is unusual in having the bed inclined instead of being horizontal, to facilitate the removal of chips.

The design, it is reported, has the additional advantage that, without increasing the height of the centers above the floor, the front wall of the bed is made deeper, thus enhancing its stiffness as a beam. The drive from the motor, which is located in the end of the box bed, is through two sets of gears, giving 18 speeds, nine from 22.5 rpm to 162 rpm, and a further nine from 208 rpm to 1500 rpm. The longitudinal feed can be set from a graduated plate to within 0.1 mm (0.004 in.) and the cross-feed to within 0.05 mm. The $12^1/_2$-hp motor is of the squirrel-cage type. A 24-volt transformer actuates the electromagnetic clutches for the forward and reverse drive to the spindle.

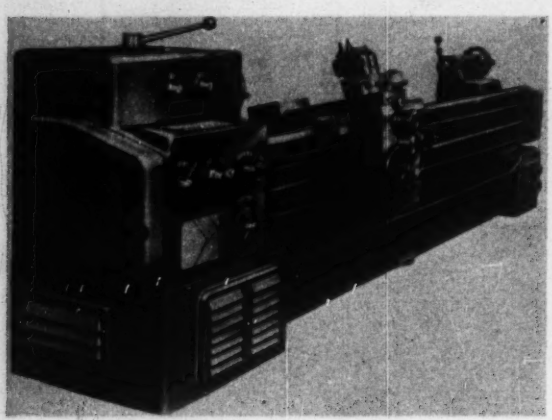


Fig. 5 General-purpose heavy-duty lathe with inclined bed

Compressed Air for Rock-Drilling

It is reported from Sweden that a considerable improvement in drilling efficiency has been effected in the iron mines at Kiruna by using portable air compressors situated near the working face instead of piping the air from a central compressing station. The improvement is stated to amount to an increase of 15 to 20 per cent in the aggregate footage of holes drilled per shift. In part, of course, this is attributable to the reduced leakage losses between the compressor and the drill, but the main reason is stated to be that the compressed air is still at a temperature of 75 C when it reaches the drill and that, in consequence, the lubrication of the drill is more effective than when the air is cooled to the very low temperatures encountered during much of the year in northern Sweden.

The tests were carried out by the Atlas Diesel Company of Stockholm, and are reported in their house journal, *Tryckluft*.

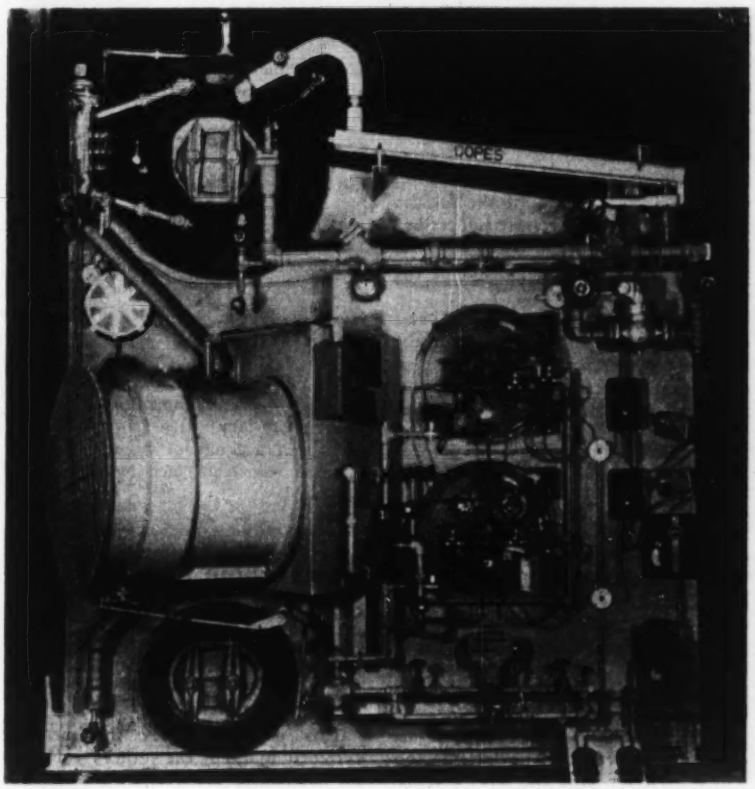
"Volumetric" Gas Turbine

Monsieur René Planche, of Villefranche-sur-Saône, France, whose small experimental gas turbine aroused considerable interest when it was described in "European Survey" in May, has contributed an article to *Le Génie Civil* (July 1, 1954) in which he discusses the possibility of constructing a gas turbine on the principle of a sliding-vane rotary blower or exhauster. The complete unit would consist of a compressor, a combustion chamber, and the sliding-vane turbine; a heat exchanger could be added if desired, to heat the air discharged from the compressor and so to recover some of the heat energy in the turbine exhaust. The edges of the sliding vanes, where they make contact with the interior surface of the casing, would be stiffened with a steel strip to prevent distortion.

Monsieur Planche calculates that, using a heat exchanger, an over-all thermal efficiency of 33 per cent could be obtained, with a fuel consumption of 175 gm per hp-hr of a fuel with a calorific value of 11,000 kcal per kg. The mechanical efficiency, he expects, would be 85 per cent.

It does not appear, however, that he has actually constructed a gas-turbine unit on these lines, but, as a manufacturer of rotary compressors and similar plant, he would be on familiar ground so far as concerned the mechanical details. The question seems to be whether such a machine would present any advantages over other types with fewer moving parts exposed to the hot gases.

Substance in Brief of Papers Presented at ASME Meetings



Packaged steam generator with standard semiautomatic controls mounted on boiler front before shipment from assembly plant

Steam Power Generation

Application of Automatically Controlled Water-Tube Packaged Steam Generators, by E. J. Lachner, Foster Wheeler Co., New York, N. Y. 1954 ASME Fall Meeting paper No. 54—F-28 (multilithographed; available to July 1, 1955).

THE paper lists physical and economic considerations of packaged steam-generator applications and discusses capacity range of single and multiple-unit installations. Approximate cost comparison is made between multiple-packaged steam generators and field-erected units. Automatic controls are discussed from the standpoint of application.

In conclusion, the following simple rules are offered for consideration when applying packaged units to steam plants:

1 Use standard products whenever possible to reduce cost to a minimum and profit by manufacturer's previous experience.

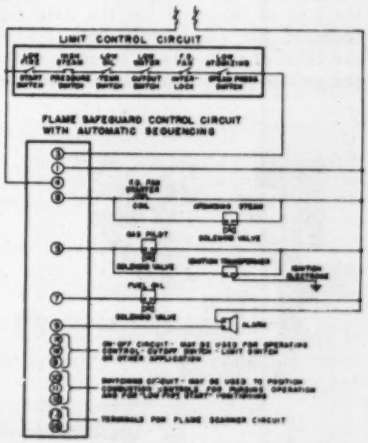
2 Consider operating and maintenance advantages of multiunit packaged-generator installations where field-erected units of larger individual capacity have been used in the past.

3 Keep controls simple. Safety and easy maintenance are essential. Investigate the opinions of the burner manufacturers who make neither controls nor boilers, but know combustion.

Selection of Control Equipment for Packaged Water-Tube Steam Generators, by A. W. Hindenlang, Combustion Engineering, Inc., New York, N. Y. 1954 ASME Fall Meeting paper No. 54—F-29 (multilithographed; available to July 1, 1955).

THE versatility and economy of the packaged water-tube steam generator for pressurized gas and oil firing have had a marked impact on the industrial boiler market. The resulting widespread acceptance of boilers of this category has led to considerable discussion on the type of control and protective equipment best-suited to this application.

A number of varying factors tend to complicate the selection of control equipment and safety devices which will suit exactly the requirements of all potential users. Yet the practice of custom-engineering each individual control system entails the loss of all the advantages of purchasing a standardized product. To insure the retention of these benefits, packaged control systems are offered in standard, performance-proved combinations of the various components. Thus most of the detail work is eliminated. The selective process requires only an engineered evaluation of system require-



Fully automatic arrangement for oil firing showing limit and flame-safeguard controls. This circuit has been reduced to its simplest form for clarity. Additional components must be added to make the system functional.

ments and selection of the standard control combination which best meets these requirements.

Among the factors which will influence the ultimate control selection are local codes and ordinances, insurance regulations, initial and operating costs, the nature of the plant load, the type of fuel to be burned, and the degree of training of maintenance personnel. Despite the apparent complexity of the selection when weighing the foregoing factors and other essential factors, the problem may be reduced to three basic decisions. Considerations fundamental to all control and protective systems for oil, gas, or combination-fired water-tube steam generators are: Flame-safeguard control—automatic or semiautomatic? limit controls—how many? and combustion controls—metering or positioning?

The suggested approach to proper control selection is to break the problem down into these three components. Selection may then be made of the proper package made up of the three standard components which suit the needs of the particular installation.

Recent Developments in Packaged Fire-Tube Boilers, by F. A. Loebel, Mem. ASME, Cleaver-Brooks Company, Milwaukee, Wis. 1954 ASME Fall Meeting paper No. 54—F-27 (multilithographed; available to July 1, 1955).

CERTAIN economic developments in recent years have favored oil and gas fuels for steam generation in many industrial areas. Since 1948, for example, the cost of No. 6 oil on the Atlantic Seaboard has consistently been below the price of coal. This, together with the greater ease of handling and storing oil, as compared with coal, increased the demand for packaged fire-tube boilers to the degree that it is estimated that over 40,000 units have now been constructed.

The growing use of natural gas, as a result of many new transmission lines, also has been a contributing factor.

During the construction boom after World War II, architects, engineers, and contractors were led to the selection of the packaged fire-tube boiler for both heating and process steam for hotels, hospitals, schools, and industrial establishments where the steam demands were in the range that unit sizes of 300 to 18,000 lb of steam per hr up to pressures of 250 psig could be used. During the period from 1948 until the present the demand for low-pressure boilers has increased to the point where it now represents a substantial portion of the manufacturing volume.

These new applications and popular acceptance brought new problems in the form of demands for certain features to meet changing economic conditions. Some of these items were:

1 The demand for automatic burners and boiler controls. The requirement for automatic burners implied automatic cold start, and for boilers as small as 1500 lb per hr of steam capacity operating on residual fuels.

2 Automation, which by its very nature often leads to less-skilled operators and less personal attention, places greater responsibility on the designer to safeguard the operation of the equipment with adequate controls and safety devices.

3 Accessibility and less maintenance are more important. The same factors which drive for more and more automation, namely, the use of less labor, and where needed, less-skilled labor, also influence the industrial design of machinery to reduce and facilitate maintenance.

4 New applications for heating, notably in schools, churches, and hospitals, have stressed the need for quiet operation.

5 The high cost of building construction has put certain limitations on boiler size, and minimum-space requirement is usually the rule.

6 The need for gas burners and combinations of gas with light oils and heavy oils. Requirements for changeover from one fuel to the other are generally manual but the burner and controls should be capable of being switched in a matter of a few minutes.

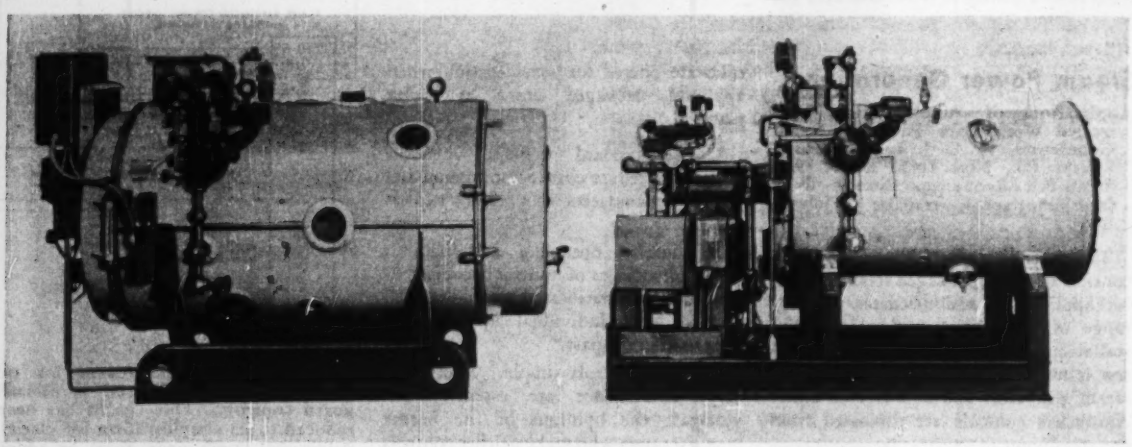
Thus changing market conditions introduced some real problems which affected both burner and boiler shell, as well as controls. The use of gas fuel, for example, in a unit which had been basically designed for oil, resulted in higher exit furnace temperatures because of less heat absorption due to the lower-flame luminosity.

A brief account of how these new requirements were met by redesign is presented.

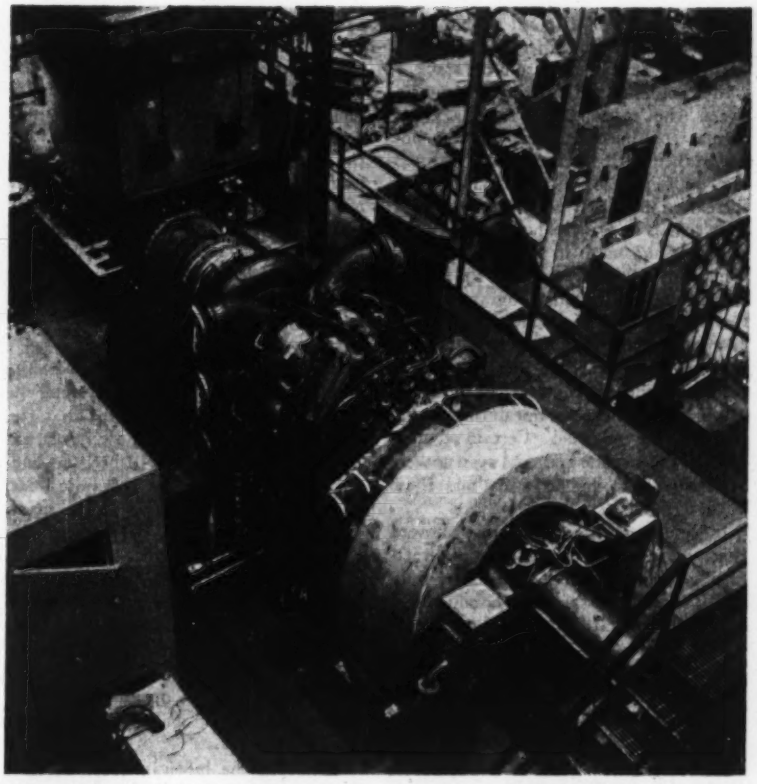
Gas Turbine Power

Gas Turbine-Power-Plant Testing, by T. D. McKone and R. L. Hendrickson, Mem. ASME, General Electric Company, Schenectady, N. Y. 1954 ASME Fall Meeting paper No. 54—F-35 (multilithographed; available to July 1, 1955).

THIS paper describes the methods currently in use by the authors' company for evaluating the over-all performance of commercial gas-turbine power plants



Comparison of an integrated boiler-burner-control unit, shown at left, with older-style unit of identical capacity



G-E 5000-hp/3500-kw two-shaft regenerative-cycle gas turbine for Texas Power and Light Company, on test stand used to test the regenerative or simple-cycle two-shaft units. Provision has been made to by-pass the regenerator when testing simple-cycle machines.

by tests in the factory before shipment.

Facilities, instrumentation, and sample test results are included. A calculation system for correcting test performance to contract or guarantee condition is suggested.

Four general types of power plants are considered; they are, in the order of increasing complexity: (*a*) Simple-cycle, single-shaft; (*b*) simple-cycle, two-shaft; (*c*) regenerative-cycle, two-shaft; and (*d*) regenerative-intercooled-cycle, two-shaft.

Testing methods and instrumentation are arranged to minimize measurement difficulties, particularly those associated with the turbine gas temperatures. Tremendous quantities of data are assembled from the most elementary test runs.

These data are required in order to establish that machines will meet or exceed contract commitments.

For factory tests, corrections to guarantee conditions have been made without specific prior agreement with the purchaser, since these are considered manufacturing tests to prove quality prior to shipment. In anticipation of testing performed in accordance with the proposed ASME Test Code, these corrections to contract conditions would require careful specification prior to the test.

Sample test results and corrections have been discussed. Conservatively estimated uncertainties in the corrections are sufficient to increase the probable error of the final test results from ±0.76 to ±1.74 per cent in power, allowing a ±10 per cent uncertainty in each correction. The intention to so design and manufacture these machines is to provide adequate margins over guaranteed performance to cover all reasonable uncertainties.

As gas-turbine power plants grow to larger sizes and more complex cycles, factory testing probably will be impractical.

It may become necessary for the manufacturer to (*a*) guarantee performance over a wider range of operating conditions, or, (*b*) supply approximate corrections to guaranteed performance for comparison with actual conditions existing at the final installation.

Acceptance and Operational Tests of a 4250-Hp Coal-Burning Gas Turbine, Part I—Preliminary Oil-Fired Operation, by J. I. Yellott, P. R. Broadley, and W. M. Meyer, Locomotive Development Committee, Bituminous Coal Research, Inc., Dunkirk, N. Y. 1954 ASME Fall Meeting paper No. 54—F-39 (multilithographed; available to July 1, 1955).

THE Locomotive Development Committee of Bituminous Coal Research, Inc., has run more than 1500 hr of acceptance and operational tests on a 4250-hp Allis-Chalmers gas-turbine power plant. The first of two papers presents the results of the oil-fired acceptance test in which the turbine shaft output at contract conditions was found to be 4257 hp, or 13.5 per cent above the warranted 3750 hp.

The test equipment was erected on two locomotive-type underframes, 40 ft long, elevated 30 in. above the concrete floor of the building. The power plant, control cabinets, and lubricating-oil system were mounted on one bed, with the coal-preparation equipment and starting diesel on the second bed.

The compressor air intake was brought in from the roof through a 48-in-diam duct in which a flow nozzle could be mounted. The turbine exhausted through a rectangular stack (21 in. × 132 in.) which extended ten feet above the roof level. The blowoff-valve vent line also extended out through the roof. All of the equipment, with the exception of these ducts and the lubricating-oil cooler, was located within locomotive space restrictions.

Four 1000-hp d-c traction generators were driven from the Falk reduction gear. Two 175-kw a-c generators, a 40-kw d-c generator, and the Regulex exciter were also driven from the reduction gear. The load for the traction generators was provided by four G.E. air-cooled resistors which discharged the heated air through the east wall of the test building.

The twin combustors were mounted above the fly-ash separator which was anchored to the underframe at the inboard end (near the turbine) but was free to slide on the outboard pedestal. The end thrusts on the high-temperature expansion joints were opposed by pistons and compensating linkages. The bellows on these joints were cooled by relatively cool air bled from the expansion joints between the regenerator outlets and the combustors.

The turbine was operated from the control panel. Load was regulated by adjusting the field current of the Regulex exciter, while fuel flow was controlled pneumatically by a Hagan air-operated valve in the oil system and a variable-speed drive on the coal pump.

The test program was planned to conform with the ASME Test Code for Gas Turbine Power Plants which was being formulated while the turbine was being constructed. The primary object of the acceptance test was to determine the net shaft output of the plant at the specified operating conditions.

Other stated primary objects were to determine: Fuel and heat consumption, characteristics of protective systems, and starting characteristics.

Fuel and heat consumption were determined at full load and partial loads by a series of oil-fired tests. Protective system and starting characteristics were explored in detail during the preliminary operating period.

Many of the secondary objectives listed in Test Code Section 1.04 were very important in the routine operation of the plant, and instrumentation was included to measure or determine the following: Temperatures of fluids and materials, pressures and pressure differences, amplitude and frequency of vibrations, plant air rate, lubricating-oil pressures and temperatures, acceleration and overload characteristics, performance of components, dimensional variations, amount of solid products in exhaust, and temperature distribution at turbine inlet.

Acceptance and Operational Tests of a 4250-Hp Coal-Burning Gas Turbine, Part II—Coal-Fired Operation, by J. I. Yellott, P. R. Broadley, and W. M. Meyer, Locomotive Development Committee, Bituminous Coal Research, Inc., Dunkirk, N. Y. 1954 ASME Fall Meeting paper No. 54—F-40 (multilithographed; available to July 1, 1955).

THE 4250-hp Allis-Chalmers gas-turbine-power plant described in Part I was first operated on coal on Sept. 23, 1951. There was no perceptible difference in the operation of the plant when the fuel control switch was thrown from "oil" to "coal." The turbine ran as smoothly on coal as on oil. The division of coal between the two combustors proved to be so nearly equal that no adjustment was required. The ash-disposal system functioned properly and there was only a slight gray haze issuing from the stack.

In accordance with the agreement between the manufacturer and L.D.C., regular coal-burning operation was not undertaken until the acceptance test was run on Sept. 28, 1951. Immediately thereafter the plant was run for 178 hr with coal as its principal fuel, oil-burning pilots being used in the combustors. When the turbine was opened for inspection at the end of this program, it was free from both erosion and deposits but a number of minor corrections were found necessary. When these were completed and the turbine was reassembled, a 750-hr test was carried out during which coal was the only fuel. Certain changes in both the turbine and coal system were again found to be necessary and these are described.

In summary, the 750-hr test showed that power can be generated by a direct-fired gas turbine using coal as its only fuel. The turbine speed can be controlled by regulating rate of admission of coal to the combustors, and the entire load range can be covered without necessity for pilot flames. Building up of ash within the system can be prevented, and maintenance of combustors and fly-ash separators is not excessive. However, blade erosion will inevitably occur when any appreciable quantity of plus 20 micron ash is permitted to pass through the turbine.

Lubrication

Lubrication in the Machine-Tool Field, by E. C. Helmke, Gisholt Machine Company, Madison, Wis. 1954 ASME Fall Meeting paper No. 54—F-38 (multilithographed; available to July 1, 1955).

THIS paper briefly reviews the history of machine-tool lubrication and discusses the problems involved in providing proper lubrication.

The following suggested line of reasoning is given to guide the machine-tool designer in specifying the proper lubricant. The machine-tool designer, to begin with, must determine whether the machine has a separate hydraulic and a separate lubrication system. He must determine what will be approximately the temperature extremes at which the machine will be operated. Again, he must know what purpose the hydraulic system serves. He should know whether the hydraulic mechanism is used for providing a feeding motion, or whether it is used only for providing certain auxiliary clamping or traversing motions.

If the machine has a separate hydraulic and a separate lubrication system, he should choose the heaviest oil that the hydraulic system will handle. Just exactly what this grade will be is dependent upon the size of the hydraulic lines, the size of the oil passages in the manifolding, and the size of any orifices, should there be an orifice type of control. Naturally, if these are large, the heavier oil can be used. It will generally be found that this heavier oil tends to give a more constant feed rate between a cold and hot machine. On the other hand, if these openings just mentioned are small, a lighter hydraulic fluid is required.

Choosing the lubricant now becomes comparatively simple in that it is only necessary to pick a lubricant that is as light as possible but that still is capable of carrying the load. A fairly good yardstick to determine the grade of lubricant is the type of gearing involved. If the mechanism involves the use of worm gearing, or similar gearing with a wiping action, the lubricant must be a bit heavier, and should have extreme pressure characteristics. The speed of the mechanism also is a factor. The old rule of thumb that says the higher the speed, the lighter the oil, is always a good one to follow.

The paper closes with the suggestion that the availability of pressure lubrication, better methods of obtaining fine surface finishes, and new synthetic ma-

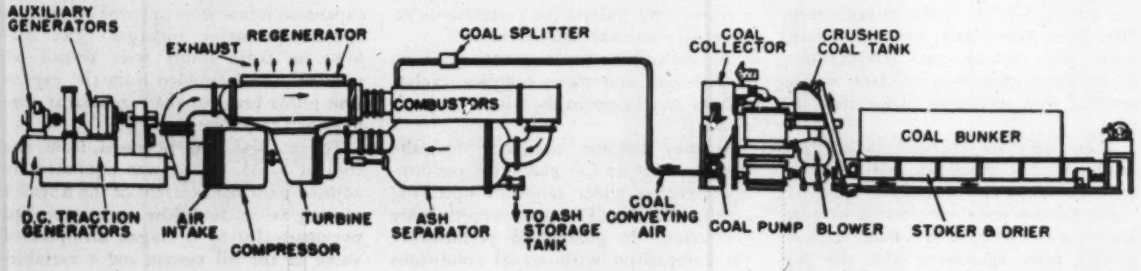


Diagram of 4250-hp locomotive direct-fired coal-burning gas-turbine test plant showing coal-preparation system

terials may provide the means for returning to the plain bearing on machine-tool spindles.

Production Engineering

How Can the Production Engineer Apply the Results of Metal-Cutting Research? by A. B. Albrecht, The Monarch Machine Tool Co., Sidney, Ohio; O. W. Boston, Mem. ASME, University of Michigan, Ann Arbor, Mich.; E. H. Lee, Mem. ASME, Brown University, Providence, R. I.; M. E. Merchant, Mem. ASME, Cincinnati Milling Machine Co., Cincinnati, Ohio; E. T. Neubauer, Mem. ASME, Trane Co., La Crosse, Wis.; Jesse Sdano, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.; and M. C. Shaw, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1954 ASME Fall Meeting paper No. 54—F-34 (multilithographed; available to July 1, 1955).

THIS is a symposium mainly relating to the industrial application of the results of metal-cutting research. Recent endeavors on metal-cutting research are discussed. The objective of the symposium was to arrive at an understanding about the direction and nature which future metal-cutting research should take to best satisfy the needs of the production engineer in industry.

Machine Design

Approximate Synthesis of Four-Bar Linkages, by Ferdinand Freudenstein, Assoc. Mem. ASME, Columbia University, New York, N. Y. 1954 ASME Fall Meeting paper No. 54—F-14 (multilithographed; available to July 1, 1955).

IN THE design of computing mechanisms it is often desired to generate arbitrary functions in which the variables are represented by an analogous quantity such as a shaft rotation. Gear and cam mechanisms have been employed for this purpose. In recent times, consideration has been given to the use of bar linkages for function generation, in particular in connection with the development of fire-control devices.

Linkages are inherently light, inexpensive, adaptable to high speeds, and are friction-free. The class of functions suitable for linkage representation is large. Mechanisms involving a finite number of links possess an inherent error and it is the task of the designer to reduce this error to a sufficiently low value. A successful design procedure must combine the predominantly analytical considerations of linkage synthesis with practical considerations involving mechanical advantages, ranges, dead-center positions, friction, and backlash.

The large number of variables occurring in the synthesis of even a single 4-bar linkage and the complexity of their interaction, render an analytical treatment difficult. The development of that portion of the field of linkage synthesis pertaining to function generation therefore has been primarily graphical. This paper presents analytical methods.

Formulas are presented for obtaining the characteristics of a 4-bar linkage, designed to generate an arbitary function approximately over a finite range.

A number of methods of varying degrees of accuracy and complexity have been developed, enabling a designer to select the one best-suited to his requirements.

Semigraphical Solution of Acceleration Problems of Plane Cam-Driven Roller Followers and Four-Bar Linkages, by Chun Hung Chiang, Taiwain University, Taipei, Taiwain, Formosa. 1954 ASME Fall Meeting paper No. 54—F-15 (multilithographed; available to July 1, 1955).

THE dynamic effect of a cam-driven follower is primarily due to its acceleration, which is a function of the curvature of the cam surface, the angular velocity and angular acceleration of the cam, and the nature of the follower. Subjects dealing with acceleration problems for flat-faced followers have been investigated and discussed by many authors, both in cam design and in cam analysis. It seems that preference between analytical (algebraic) and graphical methods has not yet been determined among kinematicians.

This paper gives a simple means for finding the angular acceleration of a cam-driven oscillating roller follower or a follower crank of a four-bar linkage, and the linear acceleration of a reciprocating follower.

Both velocity and acceleration polygons are omitted completely. Only a few computing equations and construction lines on the space diagram are needed for the solution of such problems.

Most problems solved formerly by Coriolis' law also could be solved by the present method but the construction is simpler and will result in fewer errors and higher accuracy as compared with the polygons methods.

The Geometry of Crossed Helical Involute Gears, by H. C. Gray, Mem. ASME, Falk Corp., Milwaukee, Wis. 1954 ASME Fall Meeting paper No. 54—F-10 (multilithographed; available to July 1, 1955).

THE solution of problems involving the selection of gear-tooth combinations for operation on crossed shafts is simple by the cut-and-try method, while for the solution of problems encountered in gear hobbing and gear shaving an attempt is made to clarify the geometry involved.

Because of the nature of the action of crossed helical gears, it seemed desirable to discuss them in terms of pitch cylinders instead of pitch circles, base cylinders instead of base circles, and so on.

Certain terms necessitate definitions differing somewhat from similar terms used with parallel shaft gears. These definitions are given in the appendix. Symbols conform generally to those given in ASA Letter Symbols for Gear Engineering, B6.5-1949.

Instruments and Regulators

ASME and BSI Terminologies for Process Control, by A. J. Young, Imperial Chemical Industries, Ltd., London, England. 1954 ASME Instruments and Regulators Division Conference paper No. 54—IRD-10 (multilithographed; available to July 1, 1955).

THE most recent revisions of the ASME and BSI proposals for a Standard Code of Process Control terminology are compared. The two proposals are examined, with the object of emphasizing how much they have in common and of showing how easily most of the basic differences can be reconciled. For comparison, the terms are considered in five groups: Components of process-control system, signals passing around the system, characteristics of control equipment, characteristics of process and plant, and basic concepts required for specifying control-system behavior.

A comparion is made between the two nomenclatures for the elementary components of the simple control loop.

It is concluded that the two proposals have so much in common that no great difficulty need be encountered in producing a single standard code based upon them.

The Standardization of Automatic-Control Terminology in Germany, by R. Oetker, Siemens and Halski A. G., Karlsruhe, Germany. 1954 ASME Instruments and Regulators Division Conference paper No. 54—IRD-6 (multilithographed; available to July 1, 1955).

THE preliminary work of standardizing automatic-control terminology in Germany had already begun in 1939 by members of the VDI (Verein Deutscher Ingenieure—Society of German Engineers) and the VDE (Verband Deutscher Elektrotechniker—Association of German Electrical Engineers). Due to the war, however, the work was never completed at that time.

The DNA (Deutscher Normenausschuss—German Standards Commission) took this work up again, and, in January, 1954, published a pamphlet of standard terms entitled "Automatic Control Concepts and Terms," DIN 19226. These standards are accepted and used by both the VDI and the VDE. These standards of automatic-control terminology contain terms connected with closed-loop control, and are sufficiently basic and general to be equally applicable to both the fields of process control and of servomechanisms.

The Integration of Concepts in the Terminology of Measurement and Control, by H. L. Mason, Mem. ASME, National Bureau of Standards, Washington, D. C. 1954 ASME Instruments and Regulators Division Conference paper No. 54—IRD-3 (multilithographed; available to July 1, 1955).

Problems in measurement and control arise in every field of science and technology but many aspects are common or interdependent. Examination is made of the origins, nature, spread, and fixity of the relevant American words and their glosses.

Existing agencies are noted and suggestions are made as to useful approaches to, and procedures in, terminology.

Terminology Applied to Automatic-Control Combinations, by L. A. Ledgett, Mem. ASME, Colgate-Palmolive Company, Jersey City, N. J. 1954 ASME Instruments and Regulators Division Conference paper No. 54—IRD-7 (multilithographed; available to July 1, 1955).

To aid in the understanding and acceptance of terminology published in the bulletin, "Automatic Control Terminology," by the ASME Instruments and Regulators Division Committee on Terminology, section 900, as applied to "Combination Automatic Controllers," is discussed.

Philosophy leading to, and justification for, the proposed terminology is presented with block-diagram illustrations of classified types of control combinations.

A German-English Dictionary of Automatic-Control Terms, by D. W. Pessen, Assoc. Mem. ASME, Minneapolis-Honeywell Regulator Company, Philadelphia, Pa. 1954 ASME Instruments and Regulators Division Conference paper No. 54—IRD-4 (multilithographed; available to July 1, 1955).

Since the science of automatic control is a relatively new one, most of the terms associated with it have become crystallized only during the past decade. It is therefore no wonder that existing German-English scientific dictionaries include practically no automatic-control terms. This has made it difficult for the English-speaking reader to follow the increasing German literature on the subject.

This paper presents a short German-English dictionary of automatic-control terms. The dictionary also lists many technical terms of a more general nature which are used frequently in German articles on the subject.

A list of standard German automatic-control symbols and conventions is included in the appendix.

The aim of this dictionary is not to supplant, but to supplement existing German-English scientific dictionaries, and to help the reader make use of the increasing output of German literature in the automatic-control field.

The Education and Training of Professional Engineers in the United Kingdom, by Willis Jackson, Metropolitan-Vickers Electrical Co. Ltd., Manchester, England. 1954 ASME Instruments and Regulators Division Conference paper No. 54—IRD-1 (multilithographed; available to July 1, 1955).

The education and training of professional engineers in the United Kingdom follows a different pattern than technological education in the United States. The qualifications for corporate membership in the professional Institutions of Great Britain require:

1 That the candidate shall have been educated in the scientific and engineering principles of his profession, as established by his ability to pass or obtain exemption from the Institution's examinations.

2 That he shall have been trained systematically in its practice in a manner approved by the Institution.

3 That he shall have occupied a position of adequate responsibility in engineering work for an approved period.

There are two main routes by which these requirements may be satisfied:

1 By the attainment of a university degree in the appropriate branch of engineering, followed by a two-year period of practical training under industrial or professional conditions and a minimum of two years of responsible experience.

2 By the attainment at a technical college of a Higher National Certificate in the appropriate branch of engineering, supplemented by such additional subjects as may be required by the Institution concerned, combined with practical training of at least 4 years' duration and a minimum of 2 years' responsible experience.

The products of the two schemes tend to possess somewhat different characteristics. While they have much in common, the first provides a broader and deeper knowledge of scientific and engineering principles and of mathematics, and a greater facility in applying them to new technical problems. The latter provides a more intimate knowledge of workshop and drawing-office practice and technique. These qualities are complementary, and there can be no question that industry has benefited considerably by the alternative approaches to professional status. Opportunities for advancement to positions of senior responsibility are equally open to the members of both groups. Details of education and training within these two lines of approach to professional competence are given.

Servoteaching in France With Special Reference to Aeronautical Engineers, by J. C. Gille, Technical Aeronautical Services, Paris, France. 1954 ASME Instruments and Regulators Division Conference paper No. 54—IRD-5 (multilithographed; available to July 1, 1955).

The paper gives an outline of the organization of education of engineers in France, with special reference to the present state of education in feedback-system engineering.

It points out some particular features of servoteaching in France compared to the United States—these being due to differences in the organization of education and in the background of the students.

The last part is devoted to servoteaching of aeronautical-engineering students at the École Nationale Supérieure de l'Aéronautique of Paris.

Professional Engineering Education, by L. M. K. Boelter, Fellow ASME, University of California, Los Angeles, Calif. 1954 ASME Instruments and Regulators Division Conference paper No. 54—IRD-11 (multilithographed; available to July 1,1955).

The professional engineer solves the problems of tomorrow; the technician solves today's problems. The professional engineer must accept responsibility for (1) The rational planning and design of the engineering system of our society, and (2) adding the new knowledge of the physical, biologi-

cal, and social sciences to that available at the moment as the science and as the art of engineering in ever-changing forms and recipes to meet the needs of the society of tomorrow. The technician, on the other hand, solves those problems for which methods of solution are already available, namely, the problems of the day.

The beginnings of the development of professional graduate-engineering education is a natural result of two forces: (1) The present great diversification of a fraction of engineering knowledge, and (2) the great number of historical engineering tasks which are now being absorbed by other professional and quasi-professional groups.

For the professional engineer of the future it is proposed that the activities in the four-year high-school period be intensified, where necessary, and to include emphasis on the humanities as well as on mathematics and the physical sciences. The four-year college period will resemble the present curriculum, with less specialization and with a greater emphasis on the engineering sciences. The reasoning processes, the modes of expression, and basic work in the physical and life sciences during the junior and senior years will receive attention. Less rote assignments and more opportunity for the expression of individual initiative will be encouraged. The curriculum will give the student an insight of professional engineering through both analytical and experimental design experience of an elementary nature and will lead to a BS degree. Industrial experience during this period will be encouraged and will be arranged in a manner convenient to the student, the school, and the industry.

Then will follow the graduate experience for those qualified utilizing the criteria of energy, ability, initiative, and creativeness as a basis of student selection. Depending on the academic and industrial experience arrangement, the degree of Bachelor, Master, and Doctor of Engineering will be awarded to students who meet the requirements of the respective curricula.

The Role of Measurement and Instrumentation in Engineering Education, by J. A. Hrones, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1954 ASME Instruments and Regulators Division Conference paper No. 54—IRD-8 (multilithographed; available to July 1, 1955).

THE engineer must be able to undertake new and challenging problems with a competence which rests upon a clear understanding of fundamental principles.

Basic to such understanding is a thorough knowledge of the quantities in which physical phenomena are measured and expressed. Among such quantities are force, length, time, temperature, pressure, density, concentration, composition, and the like. Knowledge of a system is expressed only when changes in the important quantities of the system can be expressed in terms of time and the disturbance causing those changes. A sound training in the engineering sciences can exist only if the problems of measurement and instrumentations are integrated into these courses.

A discussion of this philosophy with suggested methods is the subject of this paper.

Instrumentation Problems in the University, by R. J. Jeffries, Michigan State College, East Lansing, Mich. 1954 ASME Instruments and Regulators Division Conference paper No. 54—IRD-9 (multilithographed; available to July 1, 1955).

THIS paper formulates the problems posed for the university by the scope and complexities of current activities in measurement, computation, and control. It identifies problems pertaining to (*a*) Instrumentation and research, (*b*) instrumentation in existing educational programs, and (*c*) new programs in instrumentation education. The author advances some observations as to needs and approaches to solution.

Advances in Null-Type Recorder Design, by I. F. Kinnard, M. A. Princi, Mem. ASME, and A. Hansen, Jr., Mem. ASME, General Electric Company, West Lynn, Mass. 1954 ASME Instruments and Regulators Division Conference paper No. 54—IRD-12 (multilithographed; available to July 1, 1955).

THE null-type instrument has for many years provided the means for accurate measurement of process variables. The art has enjoyed continuous advance, especially from the application of electronic techniques, which have improved materially the performance of this type of instrument in its functions of indication, recording, and initiating control action. Advances in the application of present magnetic materials and newly developed semiconductor materials have now made possible further significant improvements in three important elements used in these instruments. (1) A bonded Alnico VI permanent magnet is used as a reference in place of the conventional saturated standard cell. (2) The Hall effect in germanium is the basis of a new dc-ac converter. (3) A 60-cycle electromagnetic-balancing device has been designed to operate from the output of a-c primary detectors. Using these newly developed system elements, two new null-balance recorders have been designed that offer improved accuracy and reduced maintenance.

This paper describes primarily the overall operation and performance of these two recorders—one a potentiometric instrument for use with primary detectors supplying d-c signals, and the other an a-c bridge balance instrument for use with primary detectors supplying a-c signals.

The potentiometric arrangement employs a new magnetic device for continuous and accurate standardization of the measurement circuit, resulting in the elimination of the slide-wire potentiometer and standard-cell reference of conventional systems. In addition, the instrument has a newly-developed static type of dc-ac converter.

The a-c bridge instrument provides an electromagnetic means of balancing the measurement bridge.

Common mechanical system elements are used in both instruments to facilitate the change from a-c to d-c measurement.

Ten Years of Progress in Instrumentation in the Steel Industry, by J. W. Percy, U. S. Steel Corp., Kearney, N. J. 1954 ASME Instruments and Regulators Division Conference paper No. 54—IRD-2 (multilithographed; available to July 1, 1955).

WORLD WAR II gave automatic control a tremendous "shot in the arm." That phase of controls which makes use of electronics has developed greatly since 1941. The electronic continuous balancing potentiometer has practically reduced the earlier mechanical potentiometer to obsolescence. Some instrument manufacturers no longer offer the mechanical models for sale. The advantages gained with the use of electronics have spoken for themselves.

Pneumatically operated controls have been in use industrially for a number of years but have found little favor in the steel industry. This disinterest probably was not the result of inherent weaknesses in the pneumatic control itself so much as it was the misapplications, lack of adequate maintenance, and failure to supply clean air. Within the past three or four years a number of installations of pneumatic controls have been made, some with reluctance, on an experimental basis and a few on permanent systems. Since the absolute necessity of a supply of clean, oil-free, dry air is now generally conceded, it seems quite probable that

more and more of this type of control will be used in the steel process.

Hydraulic controls are now so well established in the field that little need be said for them. However, new electronic measurement and control devices are now being offered that are extremely sensitive and almost instantaneous in operation. They may force hydraulic systems out of the running some time in the not-too-distant future.

The recovery of coal chemicals has been rather well controlled for some time. A new installation now under construction will be almost completely automatic. The control system will include the use of new miniature instruments. In this new installation more than 100 small instruments of the pneumatic type will be mounted on a graphic panel about 80 ft long. The controls will be well isolated from the process in an air-conditioned room.

The newer, modern open-hearth furnace is a well-controlled piece of equipment. To the author's knowledge, all of the furnaces built within the past ten years have been equipped with pressure control, fuel-air ratio control, roof-temperature measurement, and automatic reversal. These controls are well integrated and have proved highly advantageous.

In general, the control system used on soaking pits has not been augmented greatly in the past ten years. At least one new installation made use of a combination of pneumatic and electrical control, a change from the usual electric-hydraulic system. All of the new batteries placed in operation in recent years have been equipped with controls for temperature, pressure, and fuel-air ratio on combustion.

During the past ten years the rolling of steel, particularly heating for rolling, has been placed under just about as good control as the present state of the science offers. Three-zone, triple-fired, reheating furnaces have been built in a number of plants and have proved to be satisfactory.

Petroleum Mechanical Engineering

Mechanical Advancements in the Alkylation Process, by S. R. Stiles, The M. W. Kellogg Company. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-33 (multilithographed; available to July 1, 1955).

THE alkylation process utilizing sulphuric acid catalyst achieves considerable saving in operating and investment costs due to the advantageous features associated with the use of the Cascade Reactor. These developments are reviewed and a comparison between the Jet and the Cascade systems presented, including respective equipment sizes.

A discussion of the alkylation mechanism is included along with yields obtained from typical alkylation feed streams.

Alkylation has many advantages over catalytic polymerization because (1) isobutane as well as olefines are converted, resulting in an increased product yield; (2) alkylate is essentially free of gum-forming materials so that additives are not required; (3) alkylate has a higher tetraethyl-lead response; and (4) performance in supercharged engines is superior to catalytic polymerization gasoline product.

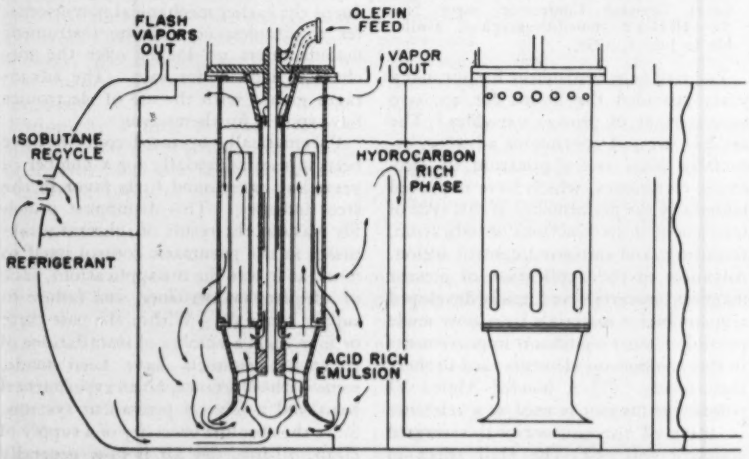


Diagram showing details of the M. W. Kellogg cascade alkylation reactor

---

In-Situ Combustion Oil-Recovery Process—Installation for Field Experiment in Jefferson County, Okla., by R. L. Koch, J. F. Gleason, Jr., and W. G. Boston, Magnolia Petroleum Company, Dallas, Tex. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-13 (multilithographed; available to July, 1, 1955).

THIS paper describes a field test of the thermal method for recovery of crude oil from underground formations based upon the generation of thermal energy by burning a small portion of the reservoir's oil while in place, i.e., "in-situ." This test was the second such test conducted in Jefferson County, Okla., and utilized a five-spot well pattern.

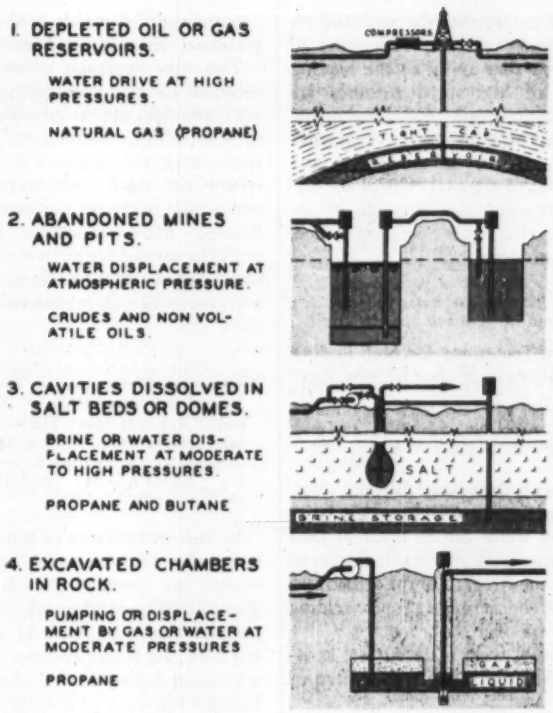
The theory is that crude oil and water are swept ahead of the burning front as a result of the combined effect of the heat generated by combustion and the flow of the combustion gases. This test produced general information on the volumetric sweep efficiency, the amount of air required to support combustion, and the air-supply requirement as related to the rate of advance of the burning front. Diagrams and photographs of the test and the test apparatus are shown and described.

Excavated Underground Storage for Petroleum Products, by R. L. Loofbourow, Minneapolis, Minn. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-25 (multilithographed; available to July 1, 1955).

UNDERGROUND storage is warehousing in reservoirs or chambers of desired capacity, usefully located, from which stored product may be removed as it is desired. Storage may be in natural reservoirs, in abandoned pits or mines, or in specially built cavities or chambers. It may be at atmospheric pressure, but underground storage is particularly suited to storage under moderate or high pressure because then the confining weight and resistance of rock may be utilized.

This paper discusses pressure storage in underground excavations, and atmospheric pressure storage in abandoned pits or mines. For perspective, it contains some information on other types.

The rapid expansion in underground storage of petroleum products is due to its economic usefulness, specifically in securely storing large volumes of products at low cost and within a reasonable distance of a desired location.


1. DEPLETED OIL OR GAS RESERVOIRS.
WATER DRIVE AT HIGH PRESSURES.
NATURAL GAS (PROPANE)
COMPRESSORS
LIGHT GAS
2. ABANDONED MINES AND PITS.
WATER DISPLACEMENT AT ATMOSPHERIC PRESSURE.
CRUDES AND NON VOLATILE OILS.
3. CAVITIES DISSOLVED IN SALT BEDS OR DOMES.
BRINE OR WATER DISPLACEMENT AT MODERATE TO HIGH PRESSURES.
PROPANE AND BUTANE
SALT
BRINE STORAGE
4. EXCAVATED CHAMBERS IN ROCK.
PUMPING OR DISPLACEMENT BY GAS OR WATER AT MODERATE PRESSURES
PROPANE
GAS
LIQUID

Types of underground storage for petroleum products

Capital costs of storage are least where natural reservoirs or abandoned mines may be used, but the total cost of storing a product may not always show the same relationship. Moreover, various types of storage are not usually comparable as to the conditions under which they may be used or as to the extent of their usefulness.

Excavated underground storage has a history of five years. It needs further development in site investigation and in means of sealing permeability. It may be used in several geological environments where other types of underground storage cannot, and it is adaptable to storage of gases, liquefied gases, and liquids.

Wind-Induced Vibration of a Pipe-Line Suspension Bridge and Its Cure, by R. C. Baird, Mem. ASME, The Fluor Corporation, Ltd., Los Angeles, Calif. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-12 (multilithographed; available to July 1, 1955).

THIS paper concerns a solution to a critical pipe-line bridge-vibration problem. The answer to the problem resulted from the application of scientific research methods. As the first step toward a solution, careful measurements were made which laid bare the fundamental cause of the trouble. Following this, several possible solutions were conceived, and the most practical appearing one was selected for testing.

Dynamic tests on models were made to verify the choice and to aid in full-scale design. Finally, a full-scale aerodynamic vibration damper was applied to the suspension bridge and the results checked by scientific measurements. The resulting solution for preventing vibration of suspension bridges is thought to be completely new, and the subject pipe-line bridge the first of its kind to which it has been applied.

A Damper for Wind-Induced Bridge Vibration—Experimental Studies, by R. C. Baird, Mem. ASME, and A. J. Ebersole, The Fluor Corporation, Ltd., Los Angeles, Calif. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-11 (multilithographed; available to July 1, 1955).

REFERENCE is made to a problem of aerodynamically induced pipe-line suspension-bridge oscillation encountered by well-known natural-gas-transmission companies. The theory underlying a proposed aerodynamic solution to the problem is discussed and the experimental apparatus devised for verifying its practical utility described. Data and results obtained experimentally are presented which show the high degree with which the proposed solution can be expected to apply to full-scale requirements.

The results indicate that tendencies for the development of disastrous wind-induced oscillation of pipe-line suspension bridges can be economically eliminated by easy application of inexpensive lightweight panels. Such paneling operates to eliminate, at their source, the oscillation-stimulating forces otherwise resulting from presence of the von Kármán Trail.

Economics of Design of Heat Exchangers, by E. B. Anderson and E. W. Flaxbart, Western Supply Company, Tulsa, Okla. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-29 (multilithographed; available to July 1, 1955).

SHELL-AND-TUBE heat-exchanger equipment usually constitutes from 5 to 15 per cent of the total equipment cost of a new gasoline plant or refinery. The selection of the proper exchanger system is very important, for upon it depends the size of the fired heaters and cooling towers—items which demand continuing operating expense. The more heat transferred by process heat exchangers, the smaller the fired heaters and cooling towers. It is necessary for the process engineer to make this economic balance and specify what he thinks to be the most economical exchanger system. But the selection is not a simple one. Corrosion, product contamination, pumping costs, and various other process considerations add to the complexity of the problem.

This paper presents curves which compare costs of various designs of shell-and-tube exchangers constructed of ferrous and nonferrous alloys. These curves will aid the engineer in making a rapid selection of the most economical exchanger for a specific service.

The Use of Electronic Digital Computers in Pipe-Line Design and Operation, by T. Y. Hicks, International Business Machine Corporation, Houston, Texas, and G. V. Rohleder, Service Pipe Line Company, Tulsa, Okla. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-31 (multilithographed; available to July 1, 1955).

TO PROPERLY evaluate the adaptability of present data processing to automatic-machine computation the following approach is suggested:

1 Obtain information on the type, purpose, volume, frequency, time limitation, accuracy, procedures, and over-all costs of analysis now being performed without the use of electronic computers.

2 Determine whether some of the present analysis can be eliminated or combined without hindering performance or whether additional analyses can be made to improve performance.

3 Determine the cost and/or intangible advantages or disadvantages of machine computation over present method.

The use of electronic digital computers by pipe lines will provide answers to problems which previously have been considered too tedious and time-consuming.

Greater economy and more effective machine utilization will usually be obtained by pooling the data-processing requirements of several departments, e.g., accounting, engineering, and operating.

On problems which have been solved by the use of electronic computers the savings on the initial calculations have been 50 per cent and up over manual methods. Since the initial planning and programming is the most time and thought-consuming and is required only once, greater savings will be realized by repetitive solutions.

Design Problems and Applications of High-Speed Turbines, by H. Steen-Johnsen, Mem. ASME, Elliott Company, Jeannette, Pa. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-3 (multilithographed; available to July 1, 1955).

A LARGE portion of the steam turbines bought by industry are for direct drive of the driven machine such as pumps, compressors, paper mills, refrigeration machines, etc. Turbines used for these drives are referred to as mechanical-drive turbines, and the horsepower spread is from 5-hp pump drives to 15,000-hp blast-furnace compressor drives and higher for special applications. These turbines may be single-stage or multistage turbines and with either single or multiple-inlet valves. In this field there is a trend to multistage machines in the small horsepowers, taking advantage of the increased efficiency of the multistage turbine.

Turbine speeds cover a wide range—from 1200 rpm up to 12,000 rpm. The majority of applications have been in the 2500 to 4000-rpm speed range but recently there is a growing demand for 3000 to 5000-hp turbines in the high-speed bracket, that is, from 7000 rpm up to, say, 12,000 rpm.

This demand for turbines originates with an increasing demand for compressor drives for refineries and other process industries such as steel-mill coke ovens, gas works, refrigeration, and so on.

This paper outlines briefly the coverage of the mechanical-drive turbine field as background for treating the main subject of high-speed turbines. The design modifications that apply to the blading and rotor of high-speed turbines are covered in some detail. Speed and horsepower limits are discussed. Governor and speed control is mentioned and various types of external control are discussed. Mention also is made of assembly, erection, and operating procedures and problems.

Electric-Arc Technique for Stub-Ending Drill Collars, by W. S. Bachman, Drilco Oil Tools, Inc., Midland, Texas. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-21 (multilithographed; available to July 1, 1955).

THE fatigue data available on thick hand-welded sections indicates that satisfactory stub welds can be made at field machine shops with reasonable factors of safety over the strength of the drill-collar pin and box connection if proper welding procedures are used.

A number of weld materials are satisfactory if the weld is free of inclusions or defects.

Proper preheat and stress relief are very essential to the success of arc-welded drill-collar stubs.

A proper design using a back-up plug or ferrule to eliminate the first bead and provide a smooth bore is advantageous.

Field Co-Ordinating Organization for Improving Efficiency of Petroleum-Refinery Maintenance, by E. C. Hermann, Esso Standard Oil Company, Bayway Refinery, Linden, N. J. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-4 (multilithographed; available to July 1, 1955).

OVER the years there has been a steady increase in the complexity of mechanical work methods used in the performance of refinery maintenance, particularly large refineries, and it has become extremely difficult to continue improving the efficiency with which men, materials, and tools are utilized. A recent reorganization of a large refinery-maintenance group, patterned after a new trend now appearing in several processing industries, is outlined.

In refineries having relatively large maintenance forces, there is a trend toward decentralization of mechanical supervision including reassignment of some individual-craft supervisor functions, concurrently with the addition of effective work-planning techniques and controls. All factors are applied to provide an organization geared to service all "on-the-spot" demands of the operating personnel efficiently and promptly.

This new approach offers a possible solution to major co-ordinating problems, provides opportunity for improved mechanical-craft training, and makes possible improved manpower utilization within the rigid trade lines that currently exist in the craft groups of most refineries. After 9 months of functioning with the revised setup, over-all efficiency improvements of 12 to 20 per cent have been noted in this maintenance effort.

Techniques Developed in Testing Reinforced Polyester Pipe, by H. D. Boggs and D. R. Longenecker, The Fibercast Corp., Sand Springs, Okla. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-14 (multilithographed; available to July 1, 1955).

IN THE manufacture of pipe from reinforced thermosetting resin, three types of resins are primarily used—polyester, phenolic-epoxy, and epoxy resins. Thus far, all commercial pipe made at Fibercast has been cast with polyester. This product, being a pioneer in its field, has not had the benefit of past years' experience, and some of the problems involved have been slow in being resolved. However, where standard procedures for similar products were found applicable, they have been used.

In this paper an attempt is made to illustrate some of the technological difficulties encountered as well as some conclusions that were made in the attempt to establish accurate physical test data.

Field-Welding of Heavy-Wall Pressure Vessels, by F. A. Upson, Standard Oil Company (Indiana), Whiting, Ind. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-5 (multilithographed; available to July 1, 1955).

IN GENERAL, it has been found that the problems encountered in the field-welding of heavy-wall vessels are not essentially different in type from these encountered in the shop-welding of such vessels. The major differences are to be found in the reduced facilities for convenience in performing the work, as a result of field conditions, which result in a change in the relative importance of many of the factors. For instance, in field work all welding usually must be done in a fixed position, provision must be made for adequate protection against the weather, extensive rigging is often required for radiography, and repair of defective welds may be much more difficult. In addition, since stress-relieving involves

insulating the vessel and oftentimes rather elaborate facilities for providing the heat and distributing it to the various parts of the vessel, the cost of field stress relief is much higher than the cost of the usual shop stress relief.

From experience gained in the field-welding of a number of new heavy-wall pressure vessels up to 5 in. thick, the author has developed a technique which offers guidance for the successful accomplishment of this phase of providing refinery facilities. Field-welding of heavy-wall pressure vessels offers many problems for solution which do not exist in the case of shop-welding similar vessels. For each of these problems the author suggests solutions in some detail, and precautionary measures which have been found justified, as well as remedial measures which occasionally are required.

Resistance of Tubular Materials to Sulphide Corrosion Cracking, by J. P. Fraser and R. S. Treseder, Shell Development Company, Emeryville, Calif. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-20 (multilithographed; available to July 1, 1955).

A TYPICAL sulphide corrosion-cracking failure of tubing in a sour gas-condensate well is described in detail. A laboratory test procedure is described which allows alloys to be related as to their resistance to sulphide corrosion cracking. Using this rating, based on the critical stress to cause cracking in a standard laboratory test, a study has been made of the relative susceptibility to cracking of a large number of heats of commercial tubular alloys (e.g., N-80, J-55, 5 per cent nickel steel, and 9 per cent nickel steel).

It has been shown that significant improvement in the resistance to cracking of commercial N-80 tubing can be effected by means of a simple tempering heat-treatment.

The Influence of High-Strength Materials on the Design and Fabrication of Layer Vessels, by G. E. Fratcher, Process Equipment Division, A. O. Smith Corp., Milwaukee, Wis. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-35 (multilithographed; available to July 1, 1955).

MATERIAL is an important criterion and one of the limiting factors in the design of high-pressure vessels. Laboratory work is continually progressing for the search of higher-strength materials of good ductility that are readily weldable for larger vessels at higher pressures.

Commercial large-size installations of pressures of 3000 to 5000 psi were the problem of yesterday and are common today. The need for materials of higher strength for the increasing pressures of tomorrow are a challenge to the supplier, the designer, and the fabricator.

Adapting Radiography to Petroleum-Industry Needs, by H. Hovland, Industrial X-Ray Engineers, Seattle, Wash. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-17 (multilithographed; available to July 1, 1955).

THE radiographic work in the petroleum industry falls into two classes:

1 Radiography required by existing codes, such as the API-ASME Pressure Vessel Code.

2 Radiography specified by the owner for the control of weld quality.

Today, by far the greatest amount of radiography in the petroleum field comes under Class 2. This is because of improvements in equipment design and methods which make radiographic control feasible from an engineering and economic viewpoint. Another reason is perhaps because owners and fabricators have become aware of the advantages of radiography for control of weld quality.

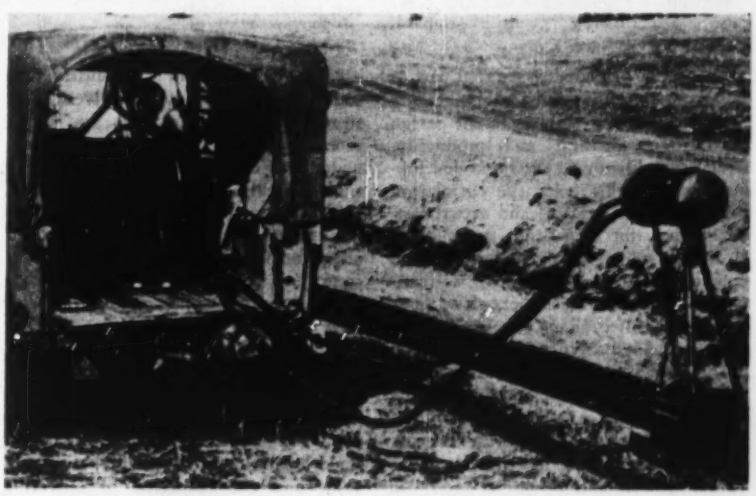
The use of radiography has changed a great deal since 1931, when the first ASME radiographic specifications were adopted. At that time radiographic specifications were solely for inspection; usually a vessel was completely welded before any radiographic tests were made. Obviously, the welding was then either acceptable or not acceptable. X-ray equipment was so bulky as to limit the method almost entirely to one location in the shop. Now improved x-ray design that permits the machine to be taken to the work permits radiographic examination immediately following welding fabrication. In addition to inspection, this provided welding supervision with a continuous control of weld quality.

Bottom-Hole Pressure Surges While Running Pipe, by E. H. Clark, Jr., Baker Oil Tools, Inc., Los Angeles, Calif. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-22 (multilithographed; available to July 1, 1955).

THIS paper deals with a method of calculating bottom-hole pressure surges due to movement of tubular goods in a well bore and the use of these values in predicting their effect on further drilling and completion.

The importance of these pressure surges is pointed out by the fact that, if not controlled, they can lead to blow-outs, lost circulation, excessive mud costs, wet-cement jobs, high gas-oil ratios through communications, or stuck drill pipe. The importance of pressure surges during casing running is emphasized, since these values are generally considerably higher than those of drill pipe. Recommended methods are presented for controlling both drill pipe and casing pressures at very little cost.

The general conclusions are that drill pipe or casing velocity, acceleration, and deceleration can and should be minimized without markedly changing drilling time. Through such action of the resultant savings in "trouble," costs will pay a thousand times over for the few dollars extra per round trip. In drilling, mud should be mixed and weighted in



X-ray equipment shown in use on small-diameter lines and refinery piping

such a manner as to maintain the plastic viscosity and yield strength at the lowest possible value consistent with other problems. Also, during casing jobs in "tight holes," particular care must be taken with dropping time, or displacements should be relieved by fill-up devices to prevent the bottom-hole pressure from causing excessive amounts of damage.

Report on the Protection of Offshore Steel Structures by a Metallurgical Method, by B. B. Morton, The International Nickel Co., Inc., New York, N. Y. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-32 (multilithographed; available to July 1, 1955).

STUDIES carried out over a long period of time indicate that three important zones of corrosion will exist upon an unprotected steel member standing in sea water and extending for a considerable distance above the sea. To economically protect such a steel structure over a long period of time, it would seem to require:

1 Cathodic protection with impressed current or galvanic anodes to protect the steel below the water level and up to the mid-tide area.

2 A resistant metal, as Monel (approx. 2/3 nickel, 1/3 copper); 70/30 copper-nickel or similar alloys, to cover the critical area from mid-tide to about 10 ft above. (Note: Only Monel used in these studies.)

3 Hot-dipped galvanizing, also painting, for the areas above the splash zone.

The Design of Offshore-Drilling Structures, by R. J. Howe, Shell Oil Company, Houston, Texas. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-19 (multilithographed; available to July 1, 1955).

THIS paper is a condensation of part of the vast amount of published engineering information which applies to the design of offshore drilling and production structures. Owing to the rapid development within this field, the correlation between the theoretical and actual conditions has not been firmly established. However, additional experimental and operating information which will become available in the next few years should aid this problem considerably.

The wind and wave forces which act on offshore structures are described in detail together with the soil reactions which hold the structures in place. The internal effects such as deflections, stresses, and natural frequencies are also discussed for a number of special cases. In addition, methods for calculating the floating stability of mobile units are presented. A general classification of offshore structures is given to illustrate the relative advantages of certain general types of structures.

Development of a Rubber-Sealed Valve for Oil-Well Drilling, by L. H. Carr, Mem. ASME, Edward Valves, Inc., East Chicago, Ind. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-15 (multilithographed; available to July 1, 1955).

A NEW alloy-steel, gate-type valve of the rubber-sealed type that will withstand high-pressure abrasive fluids and insure dependable flow control in oil-drilling mud lines as well as other rigorous industrial services is described. This new valve is now being introduced to the industry after undergoing 21 months of field testing on rotary drilling rigs in Oklahoma, Texas, and Louisiana.

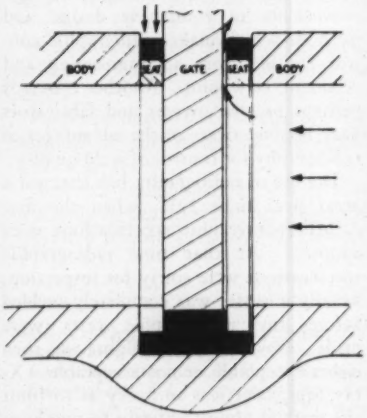


Diagram of sealing action of valve gate, seat insert, and body

Most valves users in this industry have found that they need valves with straight-through flow passages which can be repaired and maintained easily under field conditions. They also wish that the sealing action of valves in this type of service would be more or less automatic so that even if a valve is closed on foreign material or is difficult to operate, it will tend to seal itself shut and not permit damaging high-velocity flow as a result of the high pressure used in this service.

The principles of rubber sealing as developed by laboratory and field tests are outlined. The principal problems overcome were the destruction of the rubber under operation at high differential pressures and the reduction of operating torque to a point such that one man could easily operate the valve under any conditions.

Handling Viscous Crude Oils by Pipe Line, by Morgan Martin, Gulf Refining Company, Houston, Texas. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-10 (multilithographed; available to July 1, 1955).

CRUDE oils found in several of the fields of the state of Mississippi are very heavy and require heat for efficient moving by pipe line.

Baxterville oil is the heaviest of these oils and at 60 F has a viscosity of 17,400 SUS and a gravity of 16.4 API.

The first step in planning a pipe line to handle such a viscous oil is to have laboratory tests run on a sample at various temperatures in order to obtain viscosities and gravities to use in the formulas.

Additional information such as atmospheric temperatures, kind and conditions of soils through which the proposed pipe line will run, elevations along the route, are all needed, along with the viscosities and gravities, before proper design work can commence.

Calculations should be arranged in an orderly and systematic manner so ready reference can be made for the various factors shown.

The best-known data on handling heated oil in pipe lines is that found in a series of articles written by Fritz Karge, formerly chief engineer of an oil company in California.

Practical adaptation of the factors involved in the design of such a pipe line are discussed. A brief description of the mechanical equipment installed on the line is included. Operational checks are compared to the design calculations, and general observations on operations are included.

Economics and Operating Procedure of Crude-Oil Tank Mixers, by N. G. Wilson, Shell Pipe Line Corporation, Houston, Texas. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-34 (multilithographed; available to July 1, 1955).

THIS paper presents the findings of two investigations concerning mechanical mixers for use in crude-oil tanks. It is divided into two parts, namely (1) economics and (2) operating procedure.

The section on economics discusses the feasibility of mixers from the viewpoint of both pipe-line and refinery operation with the conclusion that they are economically sound. The operating procedure section of the paper summarizes the results from field tests made to determine

preferable mixer operation methods for blending crudes to prevent in-tank stratification or to reduce stratification in standing storage. Operating suggestions are included.

Allowable Membrane Stresses for Welded Carbon-Steel Boilers and Pressure Vessels, by W. P. Kerkhof, Asiatic Petroleum Corporation, New York, N. Y. 1954 ASME Petroleum Mechanical Engineering Conference paper No. **54—PET-6** (multilithographed; available to July 1, 1955).

IN THIS paper an attempt is made to find a logical compromise for the determination of the allowable maximum membrane stresses in a cylindrical shell of a boiler or pressure vessel. It is proposed that this allowable membrane stress be adopted as the base for all calculations. Stresses in other parts of the boiler or pressure vessel, for instance in domed ends, should be based on the same tabulated membrane stresses. In this case, however, the formulas should contain a special dimensionless factor which takes into account the stress raisers occurring. However, to avoid overcomplicating the considerations, these stress-concentration factors are not discussed.

Stresses From Local Loading in Cylindrical Pressure Vessels, by P. P. Bijlaard, Cornell University, Ithaca, N. Y. 1954 ASME Petroleum Mechanical Engineering Conference paper No. **54—PET-7** (multilithographed; available to July 1, 1955).

A SHORT discussion is given of the possible methods for computing the stresses caused in cylindrical shells by local loadings.

It is concluded that the method of developing the loads and displacements into double Fourier series leads to formulas which are best suited for numerical evaluation. With this method the pertinent expressions for the displacements caused by radial loads are found by reducing the three partial differential equations of the shell theory to an eighth-order differential equation in the radial displacements, which is similar to, but not identical with, those derived by Donnell and Yuan. Insertion of the Fourier series for the radial displacements and the external loading in this equation leads directly to a double-series expression of the radial displacement w n terms of the load factors Z_{mn} of the radial load. This results in the pertinent expressions for the other displacements and for the bending moments and membrane forces.

The cases of radial loading considered here and those which can be reduced to it, are (*a*) A load uniformly distributed within a rectangle, (*b*) a point load, (*c*) a moment in the longitudinal direction, uniformly distributed over a short distance in the circumferential direction, (*d*) a moment in the circumferential direction, uniformly distributed over a short distance in the longitudinal direction. For all these loadings the load factors Z_{mn}, which have to be used in the pertinent formulas for the displacements, bending moments, and membrane forces, are computed. For the case of tangential loading an eighth-order differential equation is derived in terms of the radial displacement and the tangential load. Using this equation, formulas for the displacements, bending moments, and membrane forces for tangential loading within a rectangle are found.

The Circular-Girder Four-Column Space Frame, by N. A. Weil, J. J. Murphy, Mem. ASME, P. C. Disario, and J. S. Podolan, The M. W. Kellogg Co., Jersey City, N. J. 1954 ASME Petroleum Mechanical Engineering Conference paper No. **54—PET-8** (multilithographed; available to July 1, 1955).

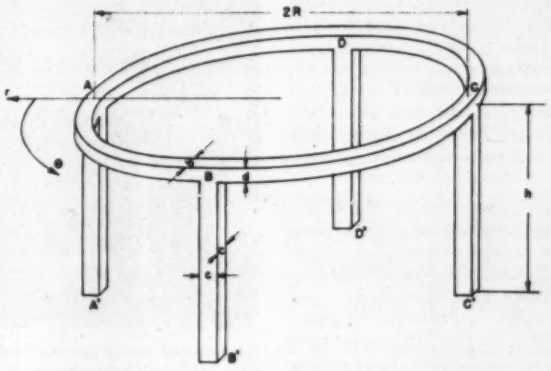
SPACE frames have an important function in industrial construction. They provide economic support at the desired elevation for structures, machinery, pressure vessels, tanks, buildings, or other equipment. In an ASCE paper entitled "The Octagonal Girder Four Column Space Frame," an original development is given by Disario, Podolan, and Weil for an octagonal ring girder supported on four columns. This was developed primarily for the support of vertical pressure vessels, tanks, or similar equipment, and for reinforced-concrete construction although not specifically limited to such. The authors demonstrated that, by their selection of the support points, torsional effects in the octagonal ring and bending moments in the columns are minimized which promotes economic design. That a circular pedestal would have similar benefits from an analytical standpoint is obvious; however, the authors of the present paper felt that an analysis of a circular pedestal which would parallel that of the octagonal pedestal would permit evaluation of their relative merits.

Accordingly, this paper presents the analysis of the circular pedestal and a comparison of results. The circular ring girder is supported on four columns located in mutually perpendicular planes, The structure may be loaded by a distributed vertical load, a concentrated horizontal shear force, or an overturning moment; the analysis includes the fixed or hinged-base conditions of the supporting columns.

The method of attack, mode of solution, and designation of forces and moments are identical with those used in the original paper on the octagonal pedestal. A polar co-ordinate system is used having its origin at the center of the circular girder; angles are positive in the counterclockwise direction and are numbered from the radius pointing to column A. The r-direction is always perpendicular to the circular girder, the θ-direction parallel to it; the positive sense of either direction follows from the definition of the co-ordinate system.

Principles of Duplex Slush-Pump Operation, by R. L. Walker, Shell Oil Company, Denver, Colo., and R. A. Tappmeyer, Shell Oil Company, Houston, Texas. 1954 ASME Petroleum Mechanical Engineering Conference paper No. **54—PET-16** (multilithographed; available to July 1, 1955).

THERE is evidence that the drilling industry as a whole is realizing that by increasing the hydraulic horsepower applied at the drill bit, higher penetration



General view of the four-column circular pedestal

rates and longer life will result. To accomplish this objective, Shell's Houston area for some time has applied the practice of high speed-high pressure parallel operation of medium-sized power slush pumps to depths of 10,000 ft. It is normal to expect, in any hydraulic system, that an increase in the magnitude and frequency of high-pressure impulses will be attended by increased maintenance and repair expense of the mud pumps and other components of the circulating system. Therefore comparable pump limitations may be experienced, and many of the cost and timesaving measures described may be necessary and have good application regardless of the pump operational method whereby the impulses are produced.

Always, heretofore, it has been said that parallel operation of mud pumps is limited to high volume-low pressure service. There is some gratification in that the time and costsaving measures adopted, and in some cases originated here, have made this a practical high volume-high pressure pumping technique. These corrective measures, along with an examination of the underlying cause of pump failures which have occurred, and our conclusions relative to the manner in which they may be minimized, or eliminated, are presented. A further objective of this paper is to examine other high volume-high pressure pumping techniques and to compare these with the parallel-pump method.

The Application of V-Belt Drives to Slush Pumps, by W. S. Worley, The Gates Rubber Company, Denver, Colo. 1954 ASME Petroleum Mechanical Engineering Conference paper No. **54—PET-28** (multilithographed; available to July 1, 1955).

IMPROVED drilling practices have required a serious re-evaluation of the part to be played by the V-belt drive as the power transmission between engines and pump. The V-belt drive has many characteristics which make it ideally adapted to the requirements of drilling service. These characteristics resulted in wide use of V-belt drives at the time when the drilling industry began to change from steam to internal-combustion power. Some of these characteristics are:

1 The horsepower rating of a V-belt drive closely parallels the horsepower output of an internal-combustion engine.

2 The V-belt drive is dependable. Because it uses belts in multiple, the failure of a single belt does not incapacitate the drive. The remaining belts assume the load, and drilling can continue without costly interruption.

3 The V-belt drive is easy to erect and dismantle. It does not require precision alignment or adjustment.

4 The V-belt drive is clean. It requires no lubrication, no dressings, and no leakproof enclosures.

5 The V-belt drive requires little maintenance. Once the drive has been set up and the belts brought to operating tension, drive tension can be maintained with very few adjustments.

This paper discusses an improved approach to the problem of establishing engineering data for the application of V-belt drives for slush-pump service; presents the data which result from that approach; points out how the use of these data can result in space and cost savings on drives for current slush-pump requirements.

Glass Coating as a Corrosion Barrier, by W. A. Deringer, A. O. Smith Corp., Milwaukee, Wis. 1954 ASME Petroleum Mechanical Engineering Conference paper No. **54—PET-18** (multilithographed; available to July 1, 1955).

THE chemical and physical properties of glass coatings are discussed. The problems involved in designing a product which is to be glass-coated are outlined. A number of applications of glass coatings to products are described where the glass coating is employed for functional rather than decorative reasons.

Glass coatings have a hardness of about 6.0 on the Moh's scale of hardness values. They have excellent resistance to rubbing abrasion but poor resistance to impact abrasion where the impact is by a hard substance. Porcelain enamels are so much better than organic coatings in rubbing abrasion, however, that the Taber abrader test must be modified if it is to be used to evaluate ceramic coatings.

Other physical properties of glass coatings follow:

1 They do not conduct electric current.

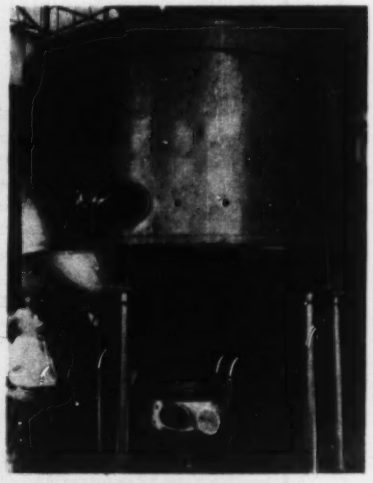
2 They have zero water absorption—which is a property that no organic coating has. Since they have no water absorption, glass coatings lend themselves extremely well to the use of cathodic protection.

3 Glass coatings will not burn or char.

4 The adherence of a glass coating to steel may be considered to be a physical property, but actually the bond is believed to be largely chemical in nature. The adhesion of glass to steel is in the range of 5000–10,000 psi.

5 Glass coatings are brittle and have little or no ductility, but it has been demonstrated that these coatings will not crack or break until the base metal to which they are applied is permanently deformed, i.e., taken past the yield point.

Glass coating is often selected as the corrosion barrier for steel for one of the following reasons: (1) Resistance to acid corrosion, (2) minimum adherence of product being processed, (3) absence of catalytic effect, (4) ease in cleaning, (5) flexibility of usage, and (6) economy.



Glass-lined tanks are used for storage of fatty acids, acid separation, fermentation, and many other like applications

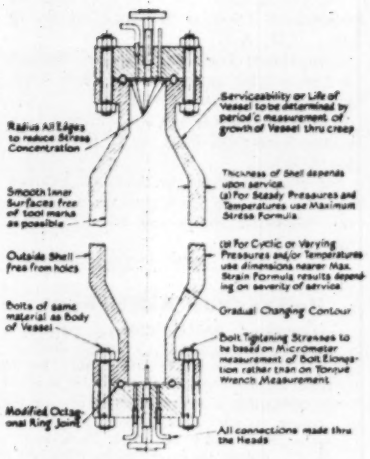
---

A Look Ahead in Pressure-Vessel Design in the Petroleum Industry, by E. W. Jacobson, Mem. ASME, Gulf Research & Development Company, Pittsburgh, Pa. 1954 ASME Petroleum Mechanical Engineering Conference paper No. **54—PET-9** (multilithographed; available to July 1, 1955).

CONTINUED intensive activity in the design and building of pressure vessels for the whole range of petroleum-processing plants both for refining of hydrocarbons and production of organic chemicals from hydrocarbons can be expected.

The solution of such vexing problems as the deterioration of steel in pressure-vessel shells from hydrogen penetration may be, partially at least, a chemical one. However, the cost of steel protection by mechanical means such as linings, etc., will need to be balanced against the cost of chemical control.

The processes carrying the major petroleum-refining burden are the low and medium-pressure ones for which pressure vessels can be designed under existing codes along well-established lines. Large size of vessels, such that field


Radius All Edges to reduce Stress Concentration
Serviceability or Life of Vessel to be determined by period c measurement of growth of Vessel thru creep
Smooth Inner Surfaces free of tool marks as possible
Thickness of Shell depends upon service (a) For Steady Pressures and Temperatures use Maximum Stress Formula
Outside Shell free from holes
(a) For Cyclic or Varying Pressures and/or Temperatures use dimensions nearer Max. Strain Formula results depending on severity of service
Bolts of same material as Body of Vessel
Gradual Changing Contour
Bolt Tightening Stresses to be based on Micrometer measurement of Bolt Elongation rather than on Torque Wrench Measurement
Modified Octagonal Ring Joint
All connections made thru the Heads

Flanged vessel design for high-temperature, high-pressure reactor service

fabrication is required, makes weld stress-relieving and inspection in the field an increasing problem.

In the field of the high-pressure processes, as soon as safe pressure vessels can be provided at reasonable cost, processes involving higher and higher temperatures and pressures will be proposed, tried, and proved. Small vessels for pressures up to 50,000 psi and reasonably large vessels up to 15,000 psi have been designed. Temperature seems somewhat of a lesser problem since internal insulation and shell cooling have been used widely with success. Quite large vessels have been designed for operation at temperatures over 2000 F.

Forged construction using the new superalloys seems to offer the better hope for safe construction particularly since it is in the forging industry where adequate heating, handling, and heat-treatment facilities are more likely to be available. The need at present is for facilities to produce the larger superalloy ingots necessary to extend their use to pressure vessels. Full use of high-strength materials and enhancement of properties by heat-treatment seem to await further development of fabrication equipment and of techniques rather than in material research.

In the field of high-pressure and temperature design, general acceptance for code purposes of the present design concepts has long been delayed. Experience is being gained in several current installations of vessels both in England and this country wherein at the operating pressure the inner wall stress is close to the yield strength of the material and the calculated fracture strength is greater than one fourth the ultimate strength. The ASME Boiler Code and the ASA B-31 Piping Code now permit high steam-temperature piping designed to steady creep conditions. It is reported that the ASME Boiler Code Committee is now engaged in examining all the factors mentioned. In time, Code requirements will recognize design concepts currently being developed for high-pressure, high-temperature service.

Free-Piston Gas-Turbine Prime Mover, by R. P. Ramsey, The Cooper-Bessemer Corporation, Mount Vernon, Ohio. 1954 ASME Petroleum Mechanical Engineering paper No. 54—PET-23 (multilithographed; available to July 1, 1955).

THE free-piston turbine combination consolidates the principle assets of the opposed piston combustion cylinder with the good points of the gas turbine canceling out a large number of the wearing parts such as the crankshaft and the connecting rods in converting linear motion to rotating motion.

Crankshaft engines have attained 40 per cent thermal efficiency. The all-rotating gas turbine with its complexities of intercooling, reheat and regeneration, and multiple components in high and low-pressure compressors with high and low-pressure turbines have not equaled the crankshaft-engine efficiency. The simple and inexpensive free-piston unit attains the lowest number of reciprocating and wearing parts and has the efficiency of the piston crankshaft-type engine together with the turbine as the driving medium.

It operates much as a steam plant with a turbine driving a load by pumping hot exhaust gas under pressure from one or more gas generators as boilers deliver their steam, but without the necessity for using an intermediate medium like steam between the source and the turbine. The free-piston turbine runs on the actual exhaust combustion gases without the heat having to pass into steam, which has to be superheated, condensed, and returned. The exhaust gases serve their purpose directly in the free-piston turbine where the network energy is extracted. There is heat remaining in the turbine exhaust which may be regained for auxiliary uses.

The greatest outstanding attribute of the free-piston engine is its essential simplicity. The elements of its design, which are attached to the free-piston principle, are absolutely trouble-free. For instance, the mechanism that keeps the pistons synchronized has never been known to give any trouble to any free-piston unit in service or on test. The pneumatic controls to regulate the stroke are taken from railroad freight-car braking systems and are simple and trouble-free.

Hydrogen Blisters in Gas Transmission Lines and Preventive Methods, by Felipe Paredes and W. W. Mize, El Paso Natural Gas Company, El Paso, Texas. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-27 (multilithographed; available to July 1, 1955).

EXPERIENCE with hydrogen blisters in a gas transmission line at low temperatures is presented. The mechanism of the blister formation, conditions necessary for hydrogen attack, experimental observations on solubility of hydrogen in

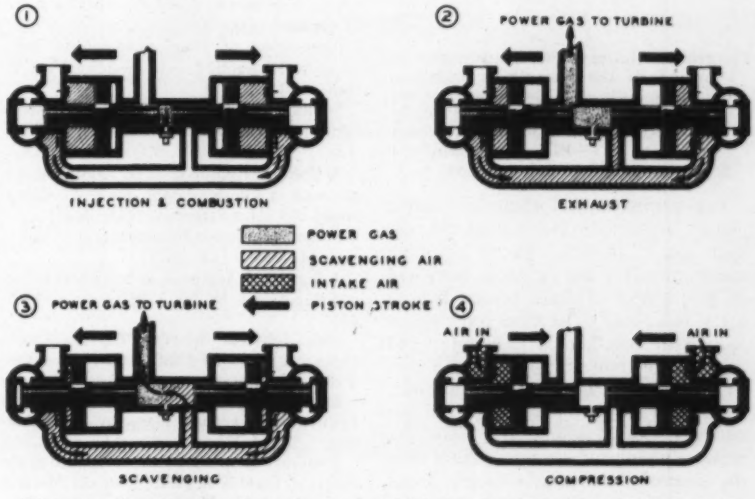


Diagram showing the free-piston gas-turbine prime-mover operating cycle

steel, diffusion rates of atomic hydrogen, and the methods of preventing attack are described.

Hydrogen blisters are of considerable academic interest and may result in expensive vessel or pipe failures. They have been successfully prevented in refineries by the use of polysulphide inhibitors and stainless-steel alloys. In a gas transmission line, they presented a new problem which was successsfully solved by the use of organic corrosion inhibitors.

Power Actuation of Flow Valves for Automation of Lease Operations, by A. A. Toben, Ledeen Manufacturing Company, Los Angeles, Calif. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-24 (multilithographed; available to July 1, 1955).

THE application of automatic controls and devices for improvement of oil-field production, dehydration, and shipping methods calls for use of a considerable number of remotely and automatically operated valves.

Better understanding of these power-operated valves and their controls may help considerably the progressive producers who are considering the use of automatic or even semiautomatic lease operating systems.

Industrial motor valves have a definite place in the design of automatic leases, but the use of power-operated, conventional flow valves will permit automation of many more production leases handling all sorts of crude oils.

Methods of power actuation of these flow valves, controls required, and selection of operating power constitute the main scope of this paper.

Electronic Automatic Control System as Applied to the Petroleum Industry, by Roger Gilliland, The Swartout Company, Alhambra, Calif. 1954 ASME Petroleum Mechanical Engineering Conference paper No. 54—PET-30 (multilithographed; available to July 1, 1955).

THE petroleum and chemical control picture is gradually eliminating the old-style locally mounted panels although many are still in use on older units and on new simple or small plants such as batch processes. The more complicated units with their higher throughputs and increased instrumentation require a centralized information center. Transmitter-receiver designs were developed for remotely located operation to eliminate pressure piping and dangerous fluids from the control-room area. Larger panel boards hastened the development of miniature instrumentation, now widely accepted.

The electronic systems available are similar in appearance to the pneumatic type. A complete system has a transmitter located at the point of measurement, a recorder, controller, and manual panel in the control room which is probably at a remote location and an electropneumatic transducer at the final control element. All transmission is accomplished instantaneously in the form of electrical quantities just as though each independent recording-controlling system were field mounted.

ASME Transactions for November, 1954

THE November, 1954, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

Frequency-Response Symposium

IRD Frequency-Response Symposium—Foreword.

The Regeneration Theory, by H. Nyquist.

Early History of the Frequency-Response Field, by A. C. Hall.

Frequency-Response Data Presentation, Standards and Design Criteria, by Rufus Oldenburger. (53—A-11)

Sine-Wave Generators, by D. W. St. Clair, L. W. Erath, and S. L. Gillespie. (53—A-12)

A Bibliography of the Frequency-Response Method as Applied to Automatic-Feedback-Control Systems, by A. M. Fuchs. (53—A-13)

The Frequency-Response Approach to the Design of a Mechanical Servo, by H. A. Helm. (54—SA-36)

Determination of Transient Response From Frequency Response, by A. Leonhard. (53—A-14)

Analysis of Regulating Systems With Particular Reference to Speed Control, by R. H. Macmillan. (53—A-15)

Application of Frequency-Analysis Techniques to Hydraulic Control Systems, by A. C. Hall. (53—A-16)

Synthesis of Optimum Feedback Systems Satisfying a Power Limitation, by J. H. Westcott. (53—A-17)

A Uniform Approach to the Optimum Adjustment of Control Loops, by R. C. Oldenbourg and Hans Sartorius. (53—A-18)

Recent Advances in Nonlinear Servo Theory, by J. M. Loeb. (53—A-19)

A Statistical Approach to Servomechanisms and Regulators, by M. J. Pélegrin. (53—A-20)

Control-System Behavior Expressed as a Deviation Ratio, by J. M. L. Janssen. (53—A-21)

Frequency-Response Analysis and Controllability of a Chemical Plant, by A. R. Aikman. (53—A-22)

Frequency-Response Methods Applied to the Study of Turbine Regulation in the Swedish Power System, by V. Oja. (53—A-23)

The Use of Zeros and Poles for Frequency Response or Transient Response, by W. R. Evans. (53—A-24)

Approximate Frequency-Response Methods for Representing Saturation and Dead Band, by Harold Chestnut. (53—A-25)

Stability Characteristics of Closed-Loop Systems With Dead Band, by C. H. Thomas. (53—A-26)

Experimental Flight Methods for Evaluating Frequency-Response Characteristics of Aircraft, by G. A. Smith and W. C. Triplett. (54—SA-3)

How to Order ASME Papers

COPIES of ASME technical papers digested this month are available until July 1, 1955. Please order only by paper *number;* otherwise the order will be returned. Orders should be addressed to the ASME Order Department, 29 W. 39th St., New York 18, N. Y. Papers are priced at 25c each to members; 50c to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. The coupons, in lots of ten, are $2 to members; $4 to nonmembers.

NOTE: No digests are made of ASME papers published in full or condensed form in other sections of MECHANICAL ENGINEERING.

Copies of all ASME publications are on file in the Engineering Societies Library and are indexed by the Engineering Index, Inc., both at 29 West 39th Street, New York, N. Y.

ASME Transactions and the *Journal of Applied Mechanics* are on file in the main public libraries of large industrial cities and in the technical libraries of engineering colleges having ASME Student Branches.

ASME Order Department
29 W. 39th St., New York 18, N. Y.

Date.....

Please send me the papers indicated by the following circled numbers:

54—F-10	54—IRD-8	54—Pet-17
54—F-14	54—IRD-9	54—Pet-18
54—F-15	54—IRD-10	54—Pet-19
54—F-27	54—IRD-11	54—Pet-20
54—F-28	54—IRD-12	54—Pet-21
54—F-29	54—Pet-3	54—Pet-22
54—F-34	54—Pet-4	54—Pet-23
54—F-35	54—Pet-5	54—Pet-24
54—F-38	54—Pet-6	54—Pet-25
54—F-39	54—Pet-7	54—Pet-27
54—F-40	54—Pet-8	54—Pet-28
54—IRD-1	54—Pet-9	54—Pet-29
54—IRD-2	54—Pet-10	54—Pet-30
54—IRD-3	54—Pet-11	54—Pet-31
54—IRD-4	54—Pet-12	54—Pet-32
54—IRD-5	54—Pet-13	54—Pet-33
54—IRD-6	54—Pet-14	54—Pet-34
54—IRD-7	54—Pet-15	54—Pet-35
	54—Pet-16	

Name.....

Address.....

☐ Remittance enclosed ☐ Bill me
☐ ASME Mem. ☐ Nonmem.

Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Hydraulic Transmissions for Locomotives

Comment by H. L. Decker[1]

IN REVIEWING this very able paper,[2] we find some interesting comparisons between the torque-converter and electrical drive. The conclusion is that a locomotive using a torque-converter transmission can be developed for main-line freight and passenger service on our railroads and have substantially the same operating characteristics for tractive effort and dynamic braking as diesels with electric drive with some slight loss in fuel economy, so slight perhaps that it will not be noticeable.

On the assumption that the performance and efficiency of the torque-converter locomotive will be substantially the same as the diesel-electric we must then look to what equipment we can take off the one and what we must put on the other to justify the change, and of course what they look like from a maintenance standpoint. It is expected that the equipment generally will be the same for both locomotives at the output flange of the diesel engine and to this point from a cost and maintenance point they are equal.

The hydraulic-drive locomotive substitutes a torque converter, speed-changing gears and clutches, drive shafts with universal and spline connections, final gear drives at the axles, for the generator, electric controls, traction motors, and final gear drives on the diesel-electric. With a six-year life for main generators between major overhauls and about 18 months or 300,000 miles for traction motors, it will be seen that the hydraulic-drive-locomotive parts are up against stiff competition.

The substitution of a direct gear drive for electric drive also presents an interesting problem in wheel work. As pointed out by the author, whatever the gear assembly used it must be competitive with the conventional electric-motor drive and wheel arrangement in ease of dropping wheels for turning and other maintenance. The author points out that wheels mechanically connected must be matched within $^1/_{32}$ in. for a 36-in. wheel. This presents a maintenance problem but the mechanical drive does have the advantage of all wheels being tied together and slipping should be reduced over the electric drive where each axle is driven independently. The maintenance of the multiplicity of drive shafts and universal joints may well be more than an electric drive with its simple spur-gear driving system.

The steady development of traction motors, particularly in improvements in insulation, has resulted in motors which can develop maximum power without time or speed restrictions. This approaches the performance of a torque-converter drive.

With a locomotive which must be equipped with dynamic braking it appears that electric drive has a definite edge. In this case the traction motors are used as generators and the power output is dissipated in resistance. With a hydraulic drive, hydraulic brakes must be provided and equipped with a clutching mechanism to engage or disengage them as required. Provisions for dissipating the heat generated must be supplied.

With equal efficiency for electric and hydraulic drives, acceptance of the hydraulic drive will rest on the ability of the gear-change and transmission units to give equivalent trouble-free service as compared with electric drives. The writer would expect that a hydraulic locomotive of the switcher type with a minimum of gear changes, in the 400 to 1200-hp range, designed for single-unit operation and without dynamic brakes will compete most successfully with a diesel-electric, both in first cost and maintenancewise. MU control, dynamic brakes, and the gearing complications of hydraulic locomotives used in main-line service lead the writer to think that we should learn to walk with the comparatively simple switcher before we try to run with a road locomotive.

The author is to be congratulated for his paper, outlining in such a clear manner the requirements for a hydraulic-drive locomotive. His analysis and charts of the comparison of electric and hydraulic-drive performances are particularly valuable in showing how closely the two types of drive can be matched.

Comment by W. F. Dadd[3]

The author's comparison of the operating efficiency of the hydraulic drive against that of the electric transmission indicates the hydraulic transmission could be used efficiently for heavier-type diesel locomotives.

The application of hydraulic drive to heavier-type diesel power should be made on new locomotives designed primarily for this type drive. The construction of present road diesel locomotives would not lend itself readily to this drive without considerable cost for modifications. Construction of trucks, clearance of body to truck, and location of engine to heavy cross members are the major conversions which have to be made.

The advantages to be gained by hydraulic transmission are basically the removal of heavy electrical transmission and subsequent control apparatus. This equipment would be replaced by starter motor, mechanical, or auxiliary-drive cooling fans, torque converter, drive-transmission shaft, and axle gear drives. The life of torque-converter and axle gear drives is questionable as compared to present generator and traction-motor life. Considerably more possibility of major failure would be present through trouble with any of the parts of the hydraulic-mechanical drive. Inspection of internal moving parts of these drives would be difficult and they could not be tested easily to assure good performance in service. The moving, flexible-drive connections under a locomotive would be subjected to heavy wear as a result of road dirt and it would be difficult to lubricate them properly. If covered and sealed to overcome this condition, they could not be inspected easily and would add to the failure hazard of the hydraulic transmission.

The use of several gear-drive ratios and clutches for speed-load efficiency would require clutch replacement and add to the possibility of drive failure. Any trouble

[1] Acting Mechanical Engineer, Chief Motive Power Division, Pennsylvania Railroad, Philadelphia, Pa. Mem. ASME.

[2] "Hydraulic Torque-Converter Transmissions for Locomotives," by J. S. Newton, MECHANICAL ENGINEERING, June, 1954, vol. 76, pp. 497–499.

[3] Baltimore and Ohio Railroad Company, Baltimore, Md.

experienced with this drive, in changing gear ratio, could result in retarding locomotive speed and bucking of other units unless the drive unit giving trouble were disengaged.

The use of a hydraulic transmission would require a very close limit in variation of wheel diameters. The limits allowed would be difficult to maintain and if operated beyond the allowed variation would result in reduction of drive efficiency. A considerably larger wheel pool would be required to maintain this minimum variation as compared to the number required at present.

The foregoing exceptions are not meant to indicate that railroads are not interested in hydraulic transmission for heavy-type power. Any good transmission which can reduce maintenance, plus original investment, will be welcomed by railroads, provided flexibility and interchangeability of parts are not affected adversely.

Considerable thought must be given to the possibility of conversion of existing power to the hydraulic transmission at the time a locomotive requires heavy repairs and parts replacement. The type drive shown in Fig. 12 of the paper does not appear to be easily adaptable to present units without major body and truck changes.

The present investment of the railroads in electric-transmission equipment requires that major consideration be given to improving the performance of this equipment rather than to replace it with a new-type drive. The present electrical control and drive have been largely responsible for the successful handling of railroad equipment by diesel-electric locomotives.

Considerable savings have been realized on locomotive maintenance with this type locomotive and a major improvement would be necessary before railroads could consider any radical departure from either the diesel engine or the electrical transmission.

Comment by R. Eksergian[4]

This paper is a mature and valuable contribution. The specifications listed are particularly important to note. Item 1, on most torque-converter applications to railway service, has been sadly neglected and, without gear changes, using the torque converter through an extended speed range, has resulted in a performance decidedly inferior to the electric drive. The Mehydro drive, using a torque converter with multiple gear changes, is shown to approach the output characteristics of modern electric transmission.

It is important to point out the necessity of gear-speed changes, in torque-converter applications for locomotives and also with many rail-car applications. Any turbine, with variable speed and constant flow rate, develops a torque dropping off with speed resulting, in turn, in a parabolic output curve. The writer has established an energy-circulating flow balance,[5] which accounted for the losses, and showed the flow rate to increase at low and overspeeds (particularly for the former) relative to the optimum flow rate at maximum efficiency. By reducing the shock losses, at unfavorable blading speeds, it is possible to improve the output curve from that of the parabolic curve in the lower speed ranges. With a split free-wheeling reaction blading, further improvements in the form of a more favorable output curve can be obtained. However, at best, improvements along these lines cannot substitute the necessity of dividing the torque-converter output into speed ranges through gear changes, as shown by the author's Figs. 8, 9, and 10.

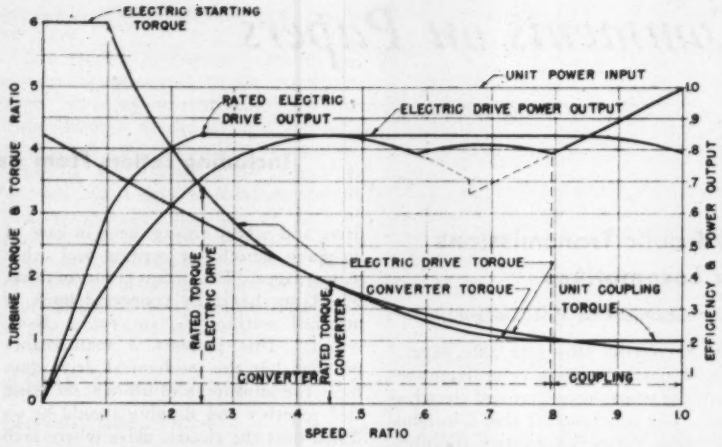


Fig. 1 Comparison of power and torque-output characteristics of torque-converter drive and electric drive

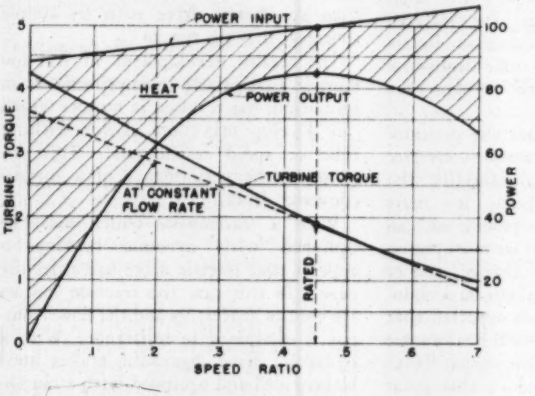


Fig. 2 Output characteristics of torque converter-constant input torque

Fig. 1 of this comment shows the application of the torque converter, with free-wheeling reaction blading assimilating a clutch into direct drive at top speeds. A comparison of an electric drive also is shown. The performance falls far short of the electric drive, particularly in the low-speed range.

Fig. 2 shows a constant-torque power input (the input increasing slightly with output speed). The output curve is approximately parabolic. The losses are crosshatched. It is evident that this drive applied to a locomotive will result in a considerable heating of the fluid, particularly with heavy drags on grades, when the optimum speed cannot be reached. With a rail car, only by the use of a high power-weight ratio, is it possible to operate above the optimum speed ratio. Reducing the power-weight ratio, as by pulling a trailer, or in applications without trailer, where with frequent stops it is necessary to operate more in the low-speed acceleration zone, will very likely cause overheating and thus limit

[4] Senior Staff Advisor, The Franklin Institute Research Laboratories; Consulting Engineer, Day & Zimmermann, Inc.; Lukens Steel Co. Worcester Reed Warner Medallist, 1939. Fellow ASME.

[5] "The Torque Converter and Fluid Coupling," by R. Eksergian, *Journal of The Franklin Institute*, vol. 235, 1943, pp. 441–478.

the capacity of the transmission for this type of service. Even more important, the output is greatly reduced, resulting in a sluggish performance compared with that of the electric drive for the same power-weight ratio. Moreover, this very feature permits a lower electric-drive power-weight ratio than for the single-gear range, torque-converter drive.

Fig. 3, herewith, shows the immediate advantage even with a two-speed torque-converter transmission. Since the ratio of starting torque to output torque at maximum efficiency, i.e., at crest of output curve, is fixed around 2.3:1, the starting tractive force can be increased only by reducing the starting-speed range. More important, the losses are inherently cut down while the power output is considerably improved in the low-speed ranges, thus permitting the pulling of trailers with single rail cars, or increasing the acceleration performance with frequent stops.

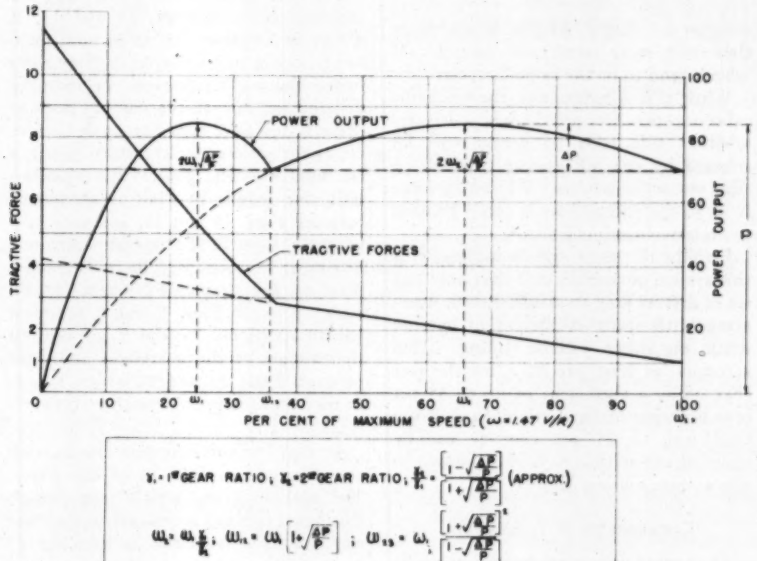


Fig. 3 Output characteristics of two-speed torque-converter transmission

To compete with the electric transmission in performance, in locomotive applications, the author points out that full output power must be obtained for a wide speed range, limiting the starting-speed range from 0.125 to 0.2 of the maximum operating speed. Since, in a speed range the output power varies approximately as a parabolic curve, the drop in power at a gear change, relative to its maximum value, must be limited. The allowable drop in power, or the minimum efficiency at a gear change, in turn, sets the speed range for a particular gear shift. The speed range itself increases with the gear shifts at the higher speeds.

While the starting-gear shift can be placed so that maximum power will be realized at a very low speed, the input power at the very start or rather the engine torque times its speed must be reduced to prevent slippage at the drivers. This, in turn, might require additional control apparatus. To prevent wheel slippage for normal operation, i.e., without reduced power, the first gear shift is better determined by the characteristics of the converter and the limiting rail adhesion.

Let ϕ = speed ratio at which maximum output is obtained. If V_m = maximum operating speed range, then assuming 0.92 transmission and 0.85 converter efficiency, the rated tractive force in terms of engine input P_E is

$$Z_R = \frac{0.92 \times 0.85 \times 375}{\phi V_m} P_E \quad \ldots [1]$$

The starting tractive force is $Z_s = 2.3\ Z_R$. If we limit this value to the adhesion tractive μW then

$$Z_s = \frac{675}{\phi V_m} P_E \leqq \mu W \quad \ldots [2]$$

hence

$$\phi = \frac{675}{\mu V_m}\left(\frac{P_E}{W}\right) \quad \ldots [3]$$

where W/P_E is the weight of the locomotive per engine horsepower.

With $W/P_E = 250$ (or 200 lb per rail hp) $\mu = 0.25$, then

$$\phi = \frac{675}{0.25 \times 250\ V_m} = \frac{10.8}{V_m} \quad \ldots [4]$$

Thus at 70-mph speed range, the first speed range would be around $\theta = 0.15$. This checks with the author's value of 0.125 to 0.2.

For any subsequent speed range it can be shown for a parabolic output power curve that

$$\Delta V = 2V_1\sqrt{\frac{\Delta P}{P}} \quad \ldots [5]$$

where ΔP = allowable drop in power, P is the peak power, and V_1 is the mean velocity in a speed range. For instance, referring to the author's Fig. 9, for the mean speed $V_1 = 30$ mph, assuming a drop in converter efficiency from 0.85 to 0.79 then

$$\frac{\Delta P}{P} = \frac{0.85 - 0.79}{0.85} = 0.07, \text{ then } \Delta V = 16$$

With $V_1 = 20$, $\Delta V = 10.6$ mph. These check closely with the author's values shown in Fig. 9 of the paper.

With a fluid coupling, the speed range, as limited by power drop is, assuming constant engine torque

$$\Delta V = V_1\frac{\Delta P}{P} \quad \ldots [6]$$

The efficiency of the coupling operates at 0.96 so that a drop to 0.79 efficiency permits a power drop $\Delta P = 0.17\ P$ while $P = 0.96$, $\Delta P/P = 0.18$, hence with $V_1 = 30$, $\Delta V = 5.4$, and $V_1 = 20$, $\Delta V = 3.6$.

These values point to full agreement with the author's conclusion as to the outstanding gear reduction effected by the converter as compared with that of the coupling for a limited power drop.

It is important to point out, however, that with a drooping engine torque against speed, the speed range of the coupling can be increased considerably, thus making gear shifts with coupling more favorable. In fact, the engine curve, to a certain extent, then replaces the effect of torque amplification in the converter.

A slippage clutch with a gear change can be operated in two ways: (*a*) With a gear change the engine speed can be maintained constant resulting in slippage of the clutch. The maximum power loss is then proportional to the maximum slippage at the beginning of a gear shift. (*b*) The engine speed can be braked down by the clutch at a gear change, so that in the subsequent speed range the engine accelerates with the locomotive. The maximum power loss then corresponds to the drop in power obtained from the power-speed characteristics of the engine.

With constant engine torque the power output is the same for either case. With a drooping engine-torque curve against speed, the power loss is reduced in the second case. The torque converter, through its reaction blading, also augments the torque when the output speed is reduced at the beginning of a gear shift. Thus the power loss at reduced speed is decreased. Actually, the torque-converter speed range straddles the peak or crest of its output-power curve. The drop in output power is the same at the beginning of a gear change as at the end, either being reduced relative to its peak output.

Comment by F. P. Gooch[6]

On the relative size of drivers the author brings up a point about which very little has been written and apparently is little understood. The identical case comes up in metal-forming machinery when two or more rolls are in contact with the same workpiece. The fact that the rolls are not exactly the same diameter causes a differential-gear action which puts the workpiece in tension or compression depending on the direction of motion.

As applied to a locomotive, the simplest case consists of two sets of drivers mechanically connected so as to have the same angular velocity. Let A be the wheel of the larger radius and B the smaller radius. Now if the author's figure of 0.1 per cent is taken as the possible difference in radius, each revolution of the wheels will roll up approximately $^1/_8$ in. of rail between the points of contact of A and B. At least this is what would happen if no slipping occurred to relieve it. Actually, either B slides forward to make up the difference in circumference or A slides backward. It is easily shown why the larger wheel always does the sliding.

In Fig. 4 let the total drawbar pull be T and let $T/2$ act at each axle.

Suppose that the larger wheel A rolls without sliding and the differential slip all occur at the point of contact of B. Then a friction force $\mu(w/2)$ will be directed to the rear or opposite to the direction of motion. The total force to the rear will be $2\,(T/2) + \mu\,(w/2)$ and the total force forward will be $\mu(w/2)$. This would result in the two wheel frictions canceling and leaving nothing for tractive effort.

The only situation compatible with the facts is for the larger wheel to slip so that both friction forces are directed forward or in the direction of motion and, assuming no acceleration of the locomotive, are equal to the drawbar pull. Since it is always the larger wheels which slide they will wear faster and in time all wheels tend to be the same diameter.

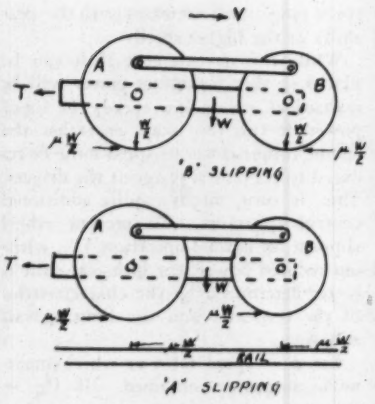


Fig. 4

While this is happening, the mechanical connection between the sets of drivers, whether side rods or gears, will be stressed by the full torque required to slide one set of wheels. While this force is large the energy loss is small because the relative motion is small.

Perhaps the most significant result of this system of mechanics is that only one set of drivers may be assumed to be operating with static coefficient of friction while the other will be sliding. This accounts, at least partially, for the fact that while a coefficient of up to 35 per cent is theroetically available, a working coefficient of 25 per cent is usually assumed and wheels have been known to slip at much lower factors.

Comment by R. T. Sawyer[7]

The author does not mention any of the troubles that have occurred with the various types of power which he describes. It is common knowledge that there are certain definite transmission troubles following a torque converter. In other words, the torque converter itself is not giving any appreciable trouble.

There are various ways of building the hydraulic-drive locomotive, two of which are shown in Fig. 12 of the paper. The author does not state how the mechanical-drive locomotive is built which produces the theoretical curves given in Fig. 8 or Fig. 9.

The writer will present a few comparisons on which the author's comment is requested.

1 Fig. 8 of the paper refers to a rail car, or so it is assumed, since Fig. 5 of this comment is similar at full load. The Maybach people make the statement that Fig. 5 is correct and Fig 6 of this comment is incorrect.

2 Fig. 6, herewith, is similar to Figs. 9 and 10 of the paper and the writer agrees with the author's statement that Fig. 9 is more suited for locomotive service than Fig. 8 because it gives better acceleration and a better over-all range of efficiency.

3 The difference in the efficiency shown in Figs. 5 and 6, herewith, Fig. 6 being the same as Fig. 10 of the paper, is about 3 per cent and must account for the axle drive shown in Fig. 14. In other words, the efficiency in Fig. 5 of this comment covers the box shown in Fig. 13 only; that is, there is no gearing between Figs. 13 and 14. If gearing is introduced between Figs. 13 and 14, it generally consists of two additional boxes, one a box to lower a drive shaft below the underframe and the second a distribution box at the truck. Both of these boxes have been disregarded, in so far as the writer can determine, in all of the figures in the paper. Furthermore, only one length of shaft is considered between Figs. 13 and 14, and for every universal joint in shafting an additional loss must be accounted for. Therefore, if we use the 3 per cent difference in efficiency between Figs. 5 and 6, we must add an additional loss of 8 per cent or thereabouts in the gearboxes and drive between Figs. 13 and 14 which has to be used on a locomotive with two swivel trucks.

4 Fig. 7 of this comment checks with the efficiency of Fig. 10 of the paper. The author of the article from which this figure is taken specifically states that the final drive to the axle is from Fig. 13 to "spiral tooth bevels" in a cast-steel casing, which indicates this is fundamentally suited for rail-car service and not a locomotive with two four-wheel swivel trucks.

5 Note the smooth curve in Fig. 7, herewith, in that it looks very similar to Fig. 3 of the paper. The writer also has checked Fig. 9 and plotted its tractive-effort curve on Fig. 3 and finds that it follows practically the bottom curve of Fig. 3. In other words, we can match the efficiency of an electric transmission by using a hydraulic torque converter, a simple gearbox, and a final drive as shown in Figs. 13 and 14. However, we definitely cannot match the electric transmission if the hydraulic-drive locomotive has the same swivel trucks and engine above the frame as in the diesel-electric locomotive unless we take an additional loss of 8 or even 12 per cent, say an average of 10 per cent, to account for the extra gearboxes, shafting, etc., required.

[6] The Franklin Institute, Philadelphia, Pa.

[7] Manager, Research Department, American Locomotive Company, New York, N. Y. Mem. ASME.

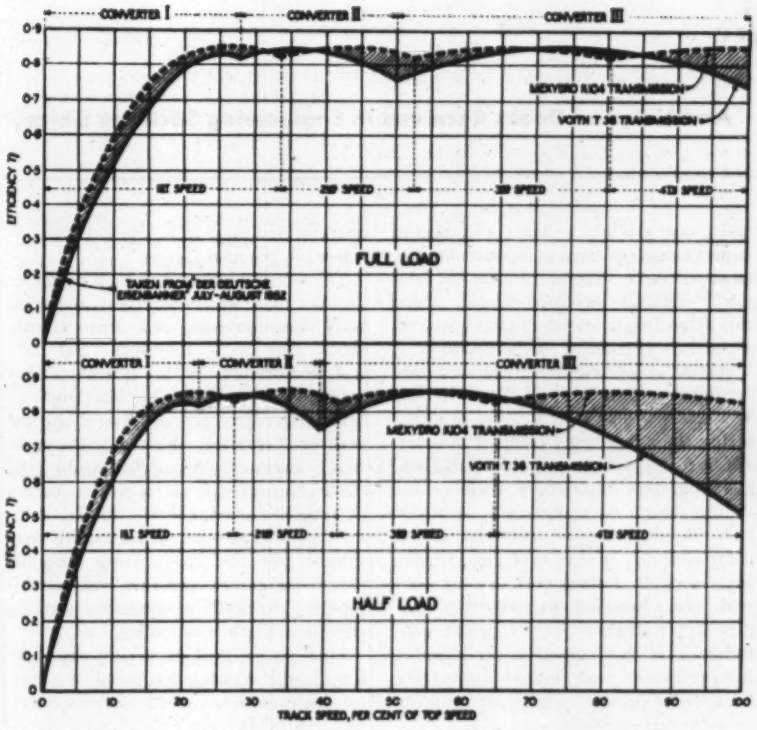


Fig. 5 Efficiency curve of Voith T-36 and Mekydro K-104 drive
(*Diesel Railway Traction*, January, 1953, from a letter signed by Maybach-Motorenbau, G.M.B.H.)

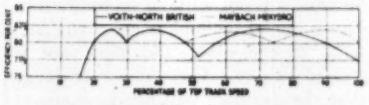


Fig. 6 Comparative efficiency curve
(*Diesel Railway Traction*, August, 1952, from article entitled, "A Survey of Transmission Systems.")

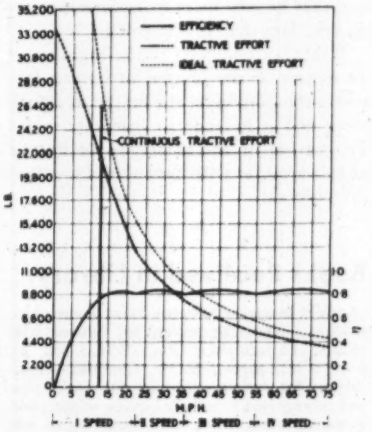


Fig. 7 Efficiency and tractive-effort curves of the K-104 Model 1000-hp transmission
(Available power after deducting auxiliaries is 940 hp which is the "ideal" curve shown with 100 per cent efficiency.)

6 The author's analysis of efficiency at lighter loads looks reasonable as shown in Fig. 10, which does not agree with the writer's Fig. 5. Particularly note in both Fig. 10 and Fig. 5 the part load moves to the left but in Fig. 5 there is absolutely no change in efficiency. One of these two curves is incorrect and the writer requests the author's explanation.

Author's Closure

The comments of Mr. Decker and Mr. Dadd from a practical and operating point of view are significant. Because of the know-how and the experience accumulated on electric transmissions, and the relative number of parts, it is to be expected that a hydraulic transmission for road locomotives for service in this country will find the competition of the electric transmission very good indeed. This is particularly true when the equivalent of dynamic braking for a hydraulic transmission is included. Mr. Dadd has raised the question of the possibility of converting the existing electric transmissions to hydraulic transmissions at the time a locomotive requires heavy repairs. From the studies it appears that the required modifications to existing locomotives are of such magnitude that it would not be economically wise to consider conversion. It would be far simpler and cheaper to produce a new locomotive than to modify existing ones.

The author is indebted to Mr. Eksergian for his comments and mathematical analysis on a torque converter versus a hydraulic coupling. While it is true that some change in engine speed is practicable at constant horsepower, it is believed that in adapting a hydraulic coupling, either the engine would have to be substantially larger, or the transmission would have to have substantially increased speed ratios as compared with a torque-converter drive for heavy-duty locomotive service.

The explanation on the effect of rigidly coupling wheels of different diameters, as explained by Mr. Gooch, is much appreciated. This has been a matter of considerable concern not only to the designer, but also to operating people. Appreciable development monies have been spent for both full scale and model tests in obtaining factual information. The theoretical explanation, simply stated, agrees with the test results.

Mr. Sawyer has requested the author's comments on some comparisons:

1 Fig. 8 of the paper could apply to either a rail car or to a locomotive. It was included to show the horsepower-speed relationship for four different gear ratios.

2 In the comments on efficiency, Mr. Sawyer concludes that the hydraulic drive locomotive with swivel trucks and engine above the frame will be approximately 10 per cent poorer in efficiency than the electric transmission. It is believed, as stated in the paper, that with a proper type of torque converter and a proper combination of gearing, the *practical operating efficiencies* of the two types of drive will be very little different. Or, stated another way, using the same diesel engine in two different locomotives, one designed for an electric transmission and the other designed for a hydraulic transmission, the fuel consumed in service in doing the same amount of work will be practically the same.

3 With regard to change in efficiency at lighter loads, it is believed that the general relationship as shown in Fig. 10 of the author's paper is correct. This is due to two effects; first, the mechanical losses at light loads become a greater percentage of the power transmitted, and second, the torque-converter-efficiency changes, generally in a downward direction, as the load is reduced.

J. S. Newton.[8]

[8] Vice-President, Baldwin-Lima-Hamilton Corporation, Philadelphia, Pa. Mem. ASME.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

Field Practice

FIELD PRACTICE (vol. 3 of DATA BOOK FOR CIVIL ENGINEERS). By Elwyn E. Seelye. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, second edition, 1954. Cloth, $4^3/_4 \times 8$ in., figs., tables, index, xvii and 394 pp., $7.50.

Reviewed by George R. Rich[1]

IN the second edition of volume 3 of this outstanding series, the objectives of the author have been extended to provide a higher degree of background knowledge. The additional features include: (1) Practical methods of field erection including descriptions of modern equipment; (2) defects in brick masonry; (3) corrosion of metals; (4) surveying; and (5) soil mechanics.

The section on soil mechanics is a clear exposition of the fundamental concepts needed by every engineer without clouding the treatment with technical refinements that are of interest only to soils specialists. The pages on field erection and construction equipment afford a condensed yet comprehensive perspective of the range and scope of modern mechanized operation in the field. In view of the current widespread difficulty in obtaining satisfactory brick masonry, the information on this phase of building construction is particularly timely. The revised edition of "Field Practice" will be found invaluable not only to the "civil-engineering inspector who aspires to be classed as a modern engineer" but also to the office designer as a condensed ready reference on field inspection and construction.

Human Engineering

HUMAN ENGINEERING GUIDE FOR EQUIPMENT DESIGNERS. By Wesley E. Woodson. University of California Press, Berkeley, Calif., 1954. Paper, $8 \times 10^1/_2$ in., figs., bibliography, reference library, subject index, six chapters, $3.50.

Reviewed by Donald M. Ross[2]

HUMAN ENGINEERING is defined in this volume as ". . . the design of human tasks, man-machine systems, and specific items of man-operated equipment for the most effective accomplishment of the job." Effective accomplishment, under this definition, connotes efficiency as well as safety and comfort of the operator.

Human engineering received its greatest impetus during World War II when, as a result of man's inability to properly utilize the increasingly complex military apparatus, psychologists, physiologists, and engineers successfully collaborated in the design of equipment. It is for this reason that most examples of accomplishment in this field concern airplane-cockpit design, tank-driving controls, radar installations, and other military applications. An important contribution of this volume is the repeated demonstration that human-engineering data can be equally useful in the solution of industrial problems.

The major problem confronting the author of any handbook, guide, or manual of human-engineering information for engineers is the sifting of literally thousands of experimental reports from all of the scientific disciplines which impinge on this new field—psychology, physiology, engineering, anthropometry, anatomy, physics, medicine, and mathematics among others—and their translation into terms for direct engineering application. The author has dealt with this problem in an effective manner by fortunate choices of examples, excellent illustrations and graphs, and the liberal use of mechanical and physical analogies.

In the manner of subject treatment the book may be roughly divided into two parts. The first section, comprised solely of chapter 1, entitled "Design of Equipment and Work Space," sets forth specific design practices for both equipment and the working environment. Here the conclusions gleaned from hundreds of individual studies of visual display, aural equipment, control design, panel layout, illumination, acoustics, and the like, are set down, usually with little verbal description but with superlative illustrations. Attention is especially directed to the simplified presentation of link analysis, the psychologist's tool for optimizing equipment arrangement whereby the frequency and importance of visual, auditory, and control links between each operator and piece of equipment are considered in the final layout.

The second section, in which might be grouped the chapters on vision, audition, body measurements, and other factors (body sensitivity, movement and control, and orientation) are largely of educational value. The author has sought to bring selected aspects of physiology and anthropometry into the ken of the practicing engineer. A careful reading of these chapters will attest to the success of this educational aim. Special commendation is due the author and his consultants for the illuminating three-dimensional graphs and the "subjective" versus "physical" comparisons used in the chapter on sound and hearing.

Finally, as though saving the best until last, the author has included a carefully selected bibliography of over three-hundred items, each thoughtfully classified according to subject matter.

Despite the over-all favorable appearance and content of this much-needed volume, it is not without its limitations. This is not a handbook in the engineering sense of the word and must not be treated as one. There is a real danger that the engineer will overlook the repeated statements that certain values are tentative or that certain dimensions are only recommended and subject to considerable variation in individual cases and that he will place more confidence in specific data than is warranted.

If this book imparts to the engineer an awareness of the myriad of human factors impinging upon the design of equipment and if it tends to stimulate wider application of the principles of human engineering, it will have served a valuable purpose.

Books Received in Library...

ASTM SPECIFICATIONS FOR STEEL PIPING MATERIALS. American Society for Testing Materials, Philadelphia, Pa., 1954. 360 p., 9×6 in., paper. $3.75. Contains specifications for carbon-steel and alloy-steel pipe and tubing used to convey liquids, vapors, and gases at normal and elevated temperatures, and for tubes for refinery stills, heat exchangers, and condensers; and boilers and superheaters. Specifications for castings, forgings, bolts, and nuts used in pipe installations are also included.

ASTM STANDARDS ON PLASTICS. American Society for Testing Materials, Philadelphia,

[1] Director, Chas. T. Main, Inc.; partner, Uhl, Hall and Rich; Boston, Mass. Mem. ASME.

[2] Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pa.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Pa., 1954. 727 p., 9 × 6 in., paper. $5.75. Includes 142 standards on properties; analytical methods; molds and molding processes; conditioning; plates, sheets, tubes, rods, and molded materials; and electrical tests.

ANALOG METHODS IN COMPUTATION AND SIMULATION. By Walter W. Soroka. McGraw-Hill Book Company, Inc., New York, N. Y., 1954. 390 p., 9¼ × 6¼ in., bound. $7.50. Describes mechanical, electromechanical, electrical, and electronic analog components for various arithmetical processes and shows how these are combined into analog computers for solving various types of equations. The mechanical differential analyzer and electronic analog computer are discussed, and there are chapters dealing with dynamical analogies, finite-difference networks, membrane analogies, and conducting sheets as applied in the simulation of physical systems and solution of differential equations.

ANALYSIS OF DEFORMATION. Volume 1: Mathematical Theory. By Keith Swainger. Chapman & Hall Ltd., London, England, (available in U. S. from The Macmillan Company, New York, N. Y.), 1954. 285 p., 8¾ × 5¾ in., bound. $12.75. In this treatise a mathematically linear theory to analyze finite deformation is formulated for all amorphous continuous substances, and general inferences are drawn without solving equations and boundary conditions for general cases. Displacement, stress, strain, and thermal considerations are discussed in the first five chapters; later chapters deal with substances having particular properties. The second volume will be devoted to the application of the theory and its experimental examination.

ATOMIC ENERGY AND ITS APPLICATIONS. By J. M. A. Lenihan. Pitman Publishing Corporation, New York, N. Y., 1954. 265 p., 7½ × 5 in., bound. $4. A simplified account of the fundamentals of nuclear science and its present and potential applications in medicine, science, and industry. Written for specialists in other fields, the book assumes a knowledge of college physics. References for further study are given at the end of each chapter.

BIBLIOGRAPHIC SURVEY OF CORROSION, 1948–1949. National Association of Corrosion Engineers, Houston, Texas, 1954. 346 p., 11 × 8½ in., bound. $12.50 (members $10). This comprehensive bibliography of 3500 abstracts, compiled from various abstracting services and a wide range of specialized indexes, is arranged according to the NACE classification. The items are listed under eight major divisions: general, testing, corrosion phenomena, corrosive environments, preventive measures, materials, equipment, and industries. Subject and author indexes are provided.

COMMUNICATION IN MANAGEMENT. By Charles E. Redfield. University of Chicago Press, Chicago, Ill., 1953. 290 p., 8⅝ × 5¾ in., bound. $3.75. This book deals with the communication problems of the executive in any type of large-scale organization. The five parts cover types of information communicated, transmission of information from superior to subordinates, reporting to the central headquarters, communication between departments, and theory and techniques. Chapter bibliographies are included.

CONDENSED PATENT PRACTICE. By Leonard M. Todd. Published by the author, 24 Fifth Avenue, New York 11, N. Y., 1954. 12 p., 11 × 8½ in., paper. $3. A series of flowsheets tracing the steps in the major procedures in patent practice including interferences, appeals, claims, taxes, plant patents, etc. Intended for the practitioner or advanced student. For the engineer it includes comprehensive references to the basic patent literature.

DEVELOPING MANAGEMENT ABILITY. By Earl G. Planty and J. Thomas Freeston. Ronald Press Company, New York, N. Y., 1954. 447 p., 9¼ × 6¼ in., bound. $7. Questions dealing with specific problems of many types of enterprises, and actually asked by executives, are given practical answers embodying the ideas and practices used by training men today. The questions are grouped in four parts covering methods and types of managerial development, organizing and operating a training program, and evaluation. A selected bibliography is included.

ELECTRIC POWER STATIONS, Volume 1. By R. H. Carr. Chapman & Hall Ltd., London, England, fourth edition, 1954. 605 p., 8¾ × 5¾ in., bound. 70s. This book deals with general principles governing design, construction, and operation. The major topics discussed are fundamentals of station design; sites and buildings; circulating-water systems; cooling towers; coal-handling plant; ash-handling plant; boiler plant; pipework; and turbines. There are chapter bibliographies.

HISTORY OF MECHANICAL INVENTIONS. By Abbott Payson Usher. Harvard University Press, Cambridge, Mass., revised edition, 1954. 450 p., 9¾ × 6¾ in., bound. $9. In this new edition of a study which first appeared in 1929, there are four new introductory chapters developing a theory of invention. Later chapters discuss the early history of mechanical sciences, pre-Christian equipment, water wheels, clocks, printing, textile machinery, clocks and watches, power production and distribution, and machine tools and mass production. A separate chapter is devoted to Leonardo da Vinci. New material has been added and the bibliography brought up to date.

MEAN ROUGHNESS COEFFICIENT IN OPEN CHANNELS WITH DIFFERENT ROUGHNESSE OF BED AND SIDE WALLS. (Mitteilungen aus der Versuchsanstalt für Wasserbau und Erdbau an der E.T.Z., no. 27.) By Ahmed M. Yassin. Verlag Leemann, Zürich, Switzerland, 90 p., 8⅞ × 6⅛ in., paper. 9.90 Sw.fr. Records experiments with three channels of different shapes and roughnesses, made to verify the H. A. Einstein equation for the mean-roughness coefficient or to find another equation of sufficient accuracy for field and laboratory experiments. Also considered is the problem of determining shearing stress on side walls and bed from the velocity distribution.

METAL STATISTICS 1954. American Metal Market, New York, N. Y., forty-seventh annual edition, 1954. 848 p., 6¼ × 4 in., bound. $3. This forty-seventh annual edition of a well-known compilation includes information similar to that of previous issues—historical and current statistics on ferrous and nonferrous metals and on related subjects such as coal and automobile production, building contract awards, and railways. Production, stocks, imports and exports, price averages, and miscellaneous economic information are given.

METALS HANDBOOK, 1954 Supplement. Edited by Taylor Lyman. American Society for Metals, Cleveland, Ohio, 1954. 184 p., 11 × 8½ in., bound. $5. In this first supplement new material is provided in fields in which the greatest advances have been made since the publication of the 1948 edition. Latest information on metals, alloys, and processes is compiled in twenty-four sections dealing with the selection of materials for various applications, design considerations, processing, and testing. Selected bibliographies are included in some sections.

MODERN DEVELOPMENTS IN FLUID DYNAMICS—HIGH SPEED FLOW. Edited by L. Howarth. Oxford University Press, New York, N. Y., 1953. Two volumes, 9½ × 6½ in., bound. Two volumes, $13.40. This is a comprehensive study of the flow of fluids, usually gases, at such high speeds that the effect of compressibility can no longer be neglected. Separate chapters prepared by various authors cover equations of flow, shock and blast waves, one-dimensional flow, experimental methods, heat transfer, and other phases of the subject. Some chapters include lists of references.

NUCLEAR REACTORS FOR INDUSTRY AND UNIVERSITIES. Edited by Ernest H. Wakefield. Instruments Publishing Company, Pittsburgh, Pa., 1954. 93 p., 8¼ × 5½ in., bound. $2. This book is a practical guide for those who wish to install a small research reactor. Eight authorities contribute chapters on the nature of nuclear energy, advantages of installing, types of radiation, control problems, prevention of radiation injury, and cost and legal factors. The cost study includes building, laboratory, and research expenses, but excludes fuel cost which is classified information.

NUMERICAL ANALYSIS. By D. R. Hartree. Oxford University Press, New York, N. Y., 1952. 287 p., 9½ × 6¼ in., bound. $4.80. A logical treatment of algebraic and analytical processes for getting certain numerical results from certain given data. Skipping the elementary arithmetical operations but avoiding the higher analytical procedures, the book keeps to the middle ground useful to engineers and research workers; methods for checking accuracy of results are provided, and there is a final chapter on organization of calculations for automatic digital calculators.

PLANT ENGINEER'S EASY PROBLEM SOLVER. By Louis J. Murphy. Conover-Mast Publications, Inc., New York, N. Y., 1954. 355 p., 9½ × 6 in., bound. $6. A manual providing numerous charts and nomograms with a minimum of text, for the solution of practical problems met in industry. Problems are considered in fifteen categories, including metalworking, refrigeration, piping, mechanical-power transmission, industrial-waste treatment, plant maintenance, etc. The charts have been kept as single as possible (the majority require only one solution line) and results are, in general, as accurate as those from a slide rule.

PLASTICS ENGINEERING HANDBOOK. The Society of Plastics Industry, Inc. Reinhold Publishing Corporation, New York, N. Y., 1954. 813 p., 9¼ × 6¼ in., bound. $15. This five-part compilation of the latest knowledge on the processing of plastics, covers ma-

terial and processes, design, finishing and assembly, testing, and standards. Roughly, half the book discusses processes—molding, preforming, extruding, drawing, casting, embedding, etc. Includes about fifty per cent more material than the original 1947 edition.

PRINCIPLES OF MASS AND FLOW PRODUCTION. By Frank G. Woollard. Published for *Mechanical Handling* by Iliffe & Sons, Ltd., London, England, 1954. 195 p., $9^3/_4 \times 6^1/_4$ in., bound. 25s. According to the author, in flow production a part passes from operation to operation in a direct and uninterrupted sequence; in mass production operations are not necessarily connected. This book discusses the principles and applications of these methods, including the application of the flow system to small-scale production. Some of the topics included are launching a new product, standardization, continuous operation, automatic-transfer machines, and the automatic factory. Examples are drawn from British, European, and American industry.

ASME BOILER CODE

Interpretations

THE Boiler and Pressure Vessel Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting September 17, 1954, and approved by the Board on November 2, 1954.)

CASE NO. 1181-1 (REOPENED)

(Interpretation of Par. P-112(c))

Revise the last sentence of the *Inquiry* to read:

May these thicknesses, and the carbon content of the carbon-molybdenum materials be increased?

Revise paragraph 2 of the *Reply* increasing the carbon content from 0.20 per cent to 0.25 per cent.

CASE NO. 1192

(Special Ruling)

Inquiry: May age-hardened nickel-copper-aluminum alloy conforming with SB-164, except that the composition and mechanical properties are as shown in the accompanying tables, be employed for bolting material for Code application:

COMPOSITION	*Per Cent*
Nickel	63.0–70.0
Aluminum	2.0– 4.0
Carbon	0.25 max
Iron	2.0 max
Silicon	1.0 max
Titanium	0.25–1.0
Sulfur	0.010 max
Copper	Remainder

and is capable of being age hardened at 1100 F.

What are the design stresses for bolting?

CASE NO. 1192—MECHANICAL PROPERTIES (Inquiry)

	Min Spec Tensile Strength, psi	Min Spec Yield Strength, psi (0.2% Offset)	Min Elongation in 2 in., %	Rc	Hardness, Min[1] Brinell, 3000 kg load
Hot or cold finished, annealed and age hardened	130,000	90,000	20	24	250
Hot finished and age hardened	140,000	100,000	20	27	265

[1] Hardness values for information only.

CASE NO. 1192—BOLTING STRESS AT TEMPERATURE DEG F (Reply)

Condition	Subzero to 80	100	200	300	400	500
Hot or cold finished annealed and age hardened	22,500	22,400	21,500	20,900	20,500	20,200
Hot finished and age hardened	25,000	24,900	24,500	24,000	23,900	23,800

Reply: It is the opinion of the Committee that age-hardened nickel-copper-aluminum alloy as described in the *Inquiry* may be employed for bolting applications. The maximum allowable bolting stresses shall be as shown in the table.

CASE NO. 1193

(Special Ruling)

Inquiry. May the revision to Par. P-242(b) for furnace of the ring-reinforced type, as published in the September, 1954, issue of MECHANICAL ENGINEERING be used in the construction of Code boilers?

Reply: It is the opinion of the Committee that the construction in the published Par. P-242(b) will meet the intent of the Code.

Annulment of Cases

CASE NO.	REASON FOR ANNULMENT
1168	External pressure charts are available

All Cases that refer to the 1949 Section VIII, Code for Unfired Pressure Vessels are to be annulled effective January 1, 1955. These Cases are:

864	1025	1077	1109
885	1038	1078	1111
896	1043	1090	1114
897	1054	1092	1115
898	1068	1100	1117
934	1074	1106	1125
994	1075	1107	1135
997	1076	1108	1139
			1140

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code. . .

AS NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers, 1952

TABLE P-7 Add the stress values given elsewhere on this page.

ADDITIONS TO TABLE P-7

Spec No.	Grade	Nominal Composition	Spec Min Tensile	Notes	For Metal Temperatures Not Exceeding Deg F: −20 to 400	500	600	650	700
PIPE & TUBES									
Seamless Alloy Steel									
SA-369	FP1	C-½ Mo	55000	(2)	13750	13750	13750	13750	13750
SA-369	FP2	½ Cr-½ Mo	55000	...	13750	13750	13750	13750	13750
SA-369	FP3b	2 Cr-½ Mo	60000	...	15000	15000	15000	15000	15000
SA-369	FP11	1¼ Cr-½ Mo-Si	60000	...	15000	15000	15000	15000	15000
SA-369	FP12	1 Cr-½ Mo	60000	...	15000	15000	15000	15000	15000
SA-369	FP21	3 Cr-1 Mo	60000	...	15000	15000	15000	15000	14800
SA-369	FP22	2¼ Cr-1 Mo	60000	...	15000	15000	15000	15000	15000
SA-369	FP5	5 Cr-½ Mo	60000	...	15000	14500	14000	13700	13400
SA-369	FP7	7 Cr-½ Mo	60000	...	15000	14500	14000	13700	13400
SA-369	FP9	9 Cr-1 Mo	60000	...	15000	14500	14000	13700	13400

Spec No.	Grade	For Metal Temperatures Not Exceeding Deg F: 750	800	850	900	950	1000	1050	1100	1150	1200
SA-369	FP1	13750	13450	13150	*12500*	*8500*	*5500*	...	...	...	...
SA-369	FP2	13750	13450	13150	12500	10000	6250	...	...	...	...
SA-369	FP3b	15000	14700	14000	12500	10000	6200	4200	2750	1750	1200
SA-369	FP11	15000	15000	14400	13100	11000	7800	5500	4000	*2500*	*1200*
SA-369	FP12	15000	14750	14200	13100	11000	7500	5000	2800	*1550*	*1000*
SA-369	FP21	14500	13900	13200	12000	9000	7000	5500	4000	2700	1500
SA-369	FP22	15000	15000	14400	13100	11000	7800	5800	4200	3000	2000
SA-369	FP5	13100	12800	12400	11500	10000	7300	5200	3300	2200	1500
SA-369	FP7	13100	12500	11500	9500	7000	5000	3500	2500	1800	1200
SA-369	FP9	13100	12800	12500	12000	10800	8500	5500	3300	2200	1500

Material Specifications, 1952

The Boiler and Pressure Vessel Committee has approved adding to Section II the following new specifications:

SA-216-53T Carbon-Steel Castings Suitable for Fusion Welding for High-Temperature Service

SA-369-53T Ferritic Alloy Steel Forged and Bored Pipe for High-Temperature Service

SB-12-54T Copper Rods for Locomotive Staybolts

SB-150-54 Aluminum Bronze Rod, Bar and Shapes

SB-211-52T Aluminum and Aluminum-Alloy Bars, Rods and Wire (*reinstated*)

Unfired Pressure Vessels, 1952

PAR. UG-23 Add "tensile" before "stress" in the second sentence of subparagraph (a).

Add a new subparagraph (*b*) to read:

(*b*) The maximum allowable compressive stress to be used in the design of cylindrical shells subjected to loadings that produce longitudinal compressive stresses in the shell shall be the smaller of the following values:

(1) The maximum allowable tensile stress value permitted in (a).

(2) The value of the factor B determined from the applicable chart in Subsection C for determining the required thickness of shells and heads under external pressure, using the following definitions for the symbols on the chart:

t_h = the minimum required thickness of the shell plates, exclusive of corrosion allowance, inches.

L_1 = inside radius of cylindrical shell, inches.

The value of B shall be determined from the applicable chart of Subsection C in the following manner:

Step 1: Assume a value of t_h. Determine the ratio $L_1/100t_h$.

Step 2: Enter the left-hand side of the chart in Subsection C for the material under consideration at the value $L_1/100t_h$ determined in Step 1.

Step 3: Move horizontally to the line marked "Sphere Line."

Step 4: From this intersection move vertically to the material line for the design temperature (see Par. UG-20). (For intermediate temperatures, interpolations may be made between the material lines on the chart.)

Step 5: From this intersection move horizontally to the right and read the value of B. This is the maximum allowable compressive stress-value for the value of t_h used in Step 1.

Step 6: Compare this value of B with the computed longitudinal compressive stress in the vessel, using the assumed value of t_h. If the value of B is smaller than the computed stress, a greater value of t_h must be selected and the procedure repeated until a value of B is obtained which is greater than the value computed for the loading on the vessel.

The joint-efficiency for butt-welded joints may be taken as unity.

Re-letter present (b) and (c) as (c) and (d) respectively.

TABLE UCS-23 Add the stress values given elsewhere on this page.

ADDITIONS TO TABLE UCS-23

Mat'l & Spec No.	Grade	Nominal Composition	Spec Min Tensile	Notes	For Metal Temperatures Not Exceeding Deg F: −20 to 650	700	750	800
PIPES & TUBES								
Seamless Low-Alloy Steels								
SA-369	FP1	C-½ Mo	55000	...	13750	13750	13750	13450
SA-369	FP2	½ Cr-½ Mo	55000	...	13750	13750	13750	13450
SA-369	FP3b	2 Cr-½ Mo	60000	...	15000	15000	15000	14700
SA-369	FP11	1¼ Cr-½ Mo-Si	60000	...	15000	15000	15000	15000
SA-369	FP12	1 Cr-½ Mo	60000	...	15000	15000	15000	14750
SA-369	FP21	3 Cr-1 Mo	60000	...	15000	14800	14500	13900
SA-369	FP22	2¼ Cr-1 Mo	60000	...	15000	15000	15000	15000
SA-369	FP5	5 Cr-½ Mo	60000	(14)	...	13400	13100	12800
SA-369	FP7	7 Cr-½ Mo	60000	(14)	...	13400	13100	12500
SA-369	FP9	9 Cr-1 Mo	60000	(14)	...	13400	13100	12800

Mat'l & Spec No.	Grade	For Metal Temperatures Not Exceeding Deg F: 850	900	950	1000	1050	1100	1150	1200
SA-369	FP1	13150	12500	10000	6250	...	...	...	...
SA-369	FP2	13150	12500	10000	6250	...	...	...	...
SA-369	FP3b	14000	12500	10000	6200	4200	2750	1750	1200
SA-369	FP11	14400	13100	11000	7800	5500	4000	2500	1200
SA-369	FP12	14200	13100	11000	7500	5000	2800	1550	1000
SA-369	FP21	13200	12000	9000	7000	5500	4000	2700	1500
SA-369	FP22	14400	13100	11000	7800	5800	4200	3000	2000
SA-369	FP5	12400	11500	10000	7300	5200	3300	2200	1500
SA-369	FP7	11500	9500	7000	5000	3500	2500	1800	1200
SA-369	FP9	12500	12000	10800	8500	5500	3300	2200	1500

Add to Note (14):

Spec	Grade	For Metal Temperatures Not Exceeding Deg F: −20 to 400	500	600	650
SA-369	FP5	15000	14500	14000	13700
SA-369	FP7	15000	14500	14000	13700
SA-369	FP9	15000	14500	14000	13700

ASME NEWS

With Notes on the Engineering Profession

Educators, Engineers, Scientists, and Industrialists Meet to Discuss Engineering Education in the United States

- **Elementary and Secondary-School Education Topic at Edison Foundation Institute**
- **Combined-Plan Conference on Liberal Arts in Engineering Education at Columbia**

● Thomas Alva Edison Foundation Institute

INDUSTRY is rendering a tremendous service to the nation in its spreading support of steps to enlarge the enrollment of science and engineering students and to improve the qualifications of their teachers, but educators and professional societies have the major responsibility in correcting the dangerous manpower shortage in these fields.

These views were presented by eminent speakers at the fifth Thomas Alva Edison Foundation Institute which opened on October 18 a two-day conference of educators, scientists, engineers, and industrialists from all over the country to discuss "Elementary and Secondary-School Education and the Survival, Strength, and Growth of the United States."

Sponsored by the Foundation, by the Engineering Manpower Commission of Engineers Joint Council, and by the Scientific Manpower Commission, the conferees appraised the impact on education of the "technological cold war," to develop definite recommendations for the alleviation of the existing shortages and the threat to the nation's economic well-being and military assurance. The ASME is one of the constituent societies of EJC.

Among the means proposed to achieve the objective were intensive efforts to communicate the need for both highly trained teachers and students well-prepared to take their places in technology. Such spreading of the gospel of scientific preparedness, it was suggested, should be undertaken at all levels from industry, government, and scientific societies down to the local levels in individual communities.

It was urged that steps be taken to increase the prestige of science teachers at the secondary-school level; accord them more definite professional standing; set higher salaries for teachers, in general, possibly with special recognition of the worth of advanced training and degrees.

That more use might be made of such visual aids as motion pictures and television in the field of science education as a means of improving teacher effectiveness and stimulating student interest was also suggested.

Open sessions were held in Glenmont, the Edison home in Llewellyn Park, West Orange, N. J., and discussion groups met in the Hotel Suburban, East Orange. The program was designated a phase of Light's Diamond Jubilee commemorating the 75th anniversary of Edison's invention of the incandescent light.

Role of Technology

Addressing the conference on "The Role of Technology—Past, Present, and Future," Vice-Admiral Harold G. Bowen, USN, Ret., Hon. Mem. ASME, executive director of the Foundation, said that technology has accomplished more for civilization than all other efforts of the human race. But, he added, it also has created new problems in human relationships.

Admiral Bowen hailed this country's industrial leadership as being due to its technological achievements and warned that "Americans will be very stupid if we do not compare the fundamentals of our industrial economy with the cause of the decline in the importance of England and Western Europe.

"This whole enormous subject of English industrial decline should be made a matter of the most serious and thorough study and investigation," urged Admiral Bowen. "Such a study is imperative if we are to profit, in time, by example."

As to this nation's technological benefits, Admiral Bowen said: "Our industrial economy has given us the highest scale of living by far ever enjoyed by any civilization. Where one third of the Roman population possessed three human slaves per capita, every American has 260 slaves per capita on an energy basis."

College Enrollment Down

M. H. Trytten, director of the Office of Scientific Personnel, National Academy of Sciences, National Research Council, found the situation of poorly qualified teachers and of an inadequate number of high-school graduates entering college "an alarming picture." He blamed lax state-licensing provisions in part responsible for poorly qualified teaching personnel.

"These are disturbing facts to face in an atomic age," said Dr. Trytten. "This is an age when all men should know more about science than ever before since science is daily increasingly affecting the lives of all of us. It is an age when both our well-being and the defense of our civilization rest most heavily on science as a foundation."

He deplored the evidence that "we seem to be de-emphasizing science in our schools rather than giving it a place commensurate with its importance in our lives." He called for a scrutiny of the secondary-school system and said that this important link in our educational system calls for extensive reorientation and reconstruction.

Scientific Societies

Howard A. Meyerhoff, executive director of the Scientific Manpower Commission, called upon the scientific societies to enlarge their activities in stimulating the interest of high-school students. He commented that the societies "belatedly became acutely aware of the fact that, as manpower shortages go, the worst is in the high-school teaching staffs." In five years, said Dr. Meyerhoff, there has

been a 50 per cent drop in the number of teachers certified to teach science, the figure reaching 75 per cent in physics. He added that "physics is moving out of the secondary schools, not for lack of student interest but for lack of good teaching."

Better Guidance Suggested

Fletcher G. Watson, James Bryant Conant lecturer at the Harvard Graduate School of Education, urged colleges to send speakers to high schools to address faculty members or the public and to encourage professors to provide guidance on technical matters and to lend equipment. He suggested that college instructors advise promising pupils who need realistic advice on projects and on career possibilities such as selecting a college fitting their interests and informing them of the availability of financial aid. He called for a greater extension in the South and in the South Central area of study opportunities provided by industries for secondary-school teachers.

Industry Meets Shortage

Albert W. Davison, of Newark, Ohio, consultant to the Owens-Corning Fiberglas Corporation, said that an increasing number of industries are turning over to technicians, under professional guidance, work previously done by trained professional people, thus striving, though in small measure, to alleviate the manpower shortage. Commenting on the salaries offered in the science and engineering fields, Dr. Davison said that "industry, as a whole, has accepted without quibbling the fact that the law of supply and demand prevails as far as manpower is concerned" and that industry "is willing to pay for the scientific and engineering manpower it needs."

Guest speakers also included Rear Admiral Lewis L. Strauss, USNR, chairman of the Atomic Energy Commission, who addressed the Institute on "The Dependence of the Free World on the Creativity of Its Engineers and Scientists"; Charles F. Kettering, Fellow ASME, research consultant to General Motors and president of the Foundation, spoke on "Energy—Man's Slave"; and Charles Edison, former Governor of New Jersey, son of the inventor, and Honorary President of the Foundation, presented the sponsor's greetings at a luncheon in Glenmont.

Standing in the den at "Glenmont," Thomas A. Edison's home in West Orange, N. J., at the fifth Thomas Alva Edison Foundation Institute on Oct. 19, 1954, are, *left to right*, Charles F. Kettering, Fellow ASME, president of the Thomas Alva Edison Foundation, The Honorable Charles Edison, honorary president of the Foundation, Rear Admiral Lewis L. Strauss, USNR, chairman of the Atomic Energy Commission, and Vice-Admiral Harold G. Bowen, USN, Ret., Hon. Mem. ASME, executive director of the Foundation.

● Combined-Plan Conference on Liberal Arts in the Education of Engineers Held at Columbia

College presidents, deans, and professors from the 43 liberal-arts colleges affiliated with the Columbia University school of engineering met October 13–15 at Arden House, Columbia's campus at Harriman, N. Y., to discuss the role of liberal arts in engineering education.

John R. Dunning, Mem. ASME, dean of the school of engineering, set the background for the conference by warning the educators of the dangers in lagging behind Russia in technology. He said that in case of another war, "half of the people and all of the major cities in the U. S. would be wiped out in the first hours." Dr. Dunning warned that "we have already lost the battle for technical manpower.

Because of skyrocketing future enrollments and critical current need for engineers, the conference was called to examine the role of the Columbia combined plan for a liberal education in engineering. Under this plan, a student attends the liberal-arts college three years and Columbia school of engineering for two years. He receives degrees from both institutions at the completion of the five years.

The conference was the first of a series to be held triennially.

Emphasize Quality of Education

Henry S. Dyer, vice-president, Educational Testing Service, Princeton, N. J., said that "getting qualified teachers would be the chief problem of liberal-arts colleges in the next ten years." He said that "while the labor force from which the teachers are drawn will have increased only 49 per cent the student population will have increased 250 per cent. This will inevitably mean a decrease in teacher quality." He said that, "because a much larger per cent of high-school graduates will go on to college, the center of gravity of intelligence will be lower." Deploring the current craze for vocational courses, Dr. Dyer said that, "private liberal-arts colleges should emphasize quality of education, rather than quantity or popularity."

He said that vocational courses for mass student bodies are the strong point of large state and municipal universities. Liberal-arts colleges shouldn't try to compete where the state institutions are strongest. He called on the educators "to use their ingenuity to make the student appreciate ideas, and to make liberal-arts education the preliminary to professional training, rather than preprofessional training."

Return to Ideas

Howard Mumford Jones, professor of English literature at Harvard University, asked for a return to ideas in teaching. He said, "liberal-arts education has been traditionally the fountain of ideas. Today, however, the wave of anti-intellectualism in America is cause, or effect, of fear of ideas."

Dr. Jones condemned the lack of cheerfulness in college courses. He said, "the emphasis has been on man's frailty, rather than his strength. The failures are more stressed than the triumphs. Liberal arts and engineering and science are a good combination, when rationality is stressed. Science is rational, but liberal arts have tended to play up the irrationality of man."

Continuing on the cheerful side, Dr. Mario Salvadori of Columbia School of Engineering, professor of civil engineering, said that, "man is on the verge of the greatest era in history. Science's greatest contribution to man is to teach him that he can accomplish more by teamwork than in competition. Scientists," he said, "work together in an intimate creative act, which no single genius could produce alone."

Fundamental Teaching Stressed

Clarence H. Linder, Mem. ASME, vice-president in charge of engineering services,

General Electric Company, told the meeting that "industry is negligent in telling colleges what their needs are." He said that General Electric has been trying to do that.

"Many colleges have tended to become trade schools," he said, "which General Electric doesn't want. The electrical industry will need many more engineers in the future. In fact, the electrical industry will produce as much in the next ten years as it has in the past 75." He also said that atomic energy is "absolutely essential" to the electrical industry to meet this expansion. "Fossile fuels can't take care of this growth."

"There is too much tendency on the part of engineering schools to train in specifics," he said. "We in G.E. don't want specialists at the bachelor level. We want people with good fundamental science and mathematics. If we want specialists, we hire PhD's."

"A man whose training has emphasized current technology can't keep up with the changing world," he said. "The conception of the corporate citizen has grown up in recent years. Since so many of the top industrial executives are engineers, they cannot isolate themselves from the world. Here liberal-arts training is essential. Technical people must be skilled in communication of ideas. That causes more trouble in G.E. than anything else. We must produce versatile young men trained thoroughly in basic science. They must be able to cope with the problems of 10 to 15 years from now. The present is already past in technology."

Better Engineers Needed

Lawrence H. Chamberlain, dean of Columbia College, said that our very survival a decade hence may depend upon technical superiority. He said that "our chances of competing with the Soviet Union on favorable terms cannot be done quantitatively. They outbreed us. We want better engineers."

"The problems that threaten to destroy our very culture and civilization are not technical problems," he continued, "they contain elements of science and technology, but also elements of history, philosophy, religion, sociology, and economics, not to mention old-fashioned common sense. The individuals to whom we must look for guidance will be those who have compounded their capacity for vision and penetration by drawing upon all the resources of wisdom and understanding available to mankind."

Dean Chamberlain said, "It is to the credit of the Engineering School at Columbia that the idea of requiring a solid liberal-arts foundation for students headed for engineering has always had fine support, despite persistent evidence that from a competitive point of view this requirement placed it at a disadvantage."

He said, "The combined plan has advantages over the plan to introduce liberal-arts courses into regular engineering curricula in that there are plenty of good liberal-arts colleges ready now to do a good job, that their staffs have more experience, that the liberal-arts teacher is happier in a liberal-arts college, students get more personal attention in liberal-arts colleges, and that students can experiment with several fields before committing themselves to engineering. Thus, if they flunk out in the second or third year, they merely transfer to another field."

The conference concluded that the three-two plan for liberal arts-engineering education was not only a desirable but a necessary part of the American educational system for science and technological manpower.

The Right Honorable C. D. Howe, *left*, Hon. Mem. ASME, recipient of the Daniel Guggenheim award, looks over scroll and medal with J. Carlton Ward, Jr., Mem. ASME, who made the presentation in Los Angeles, Calif., October 8, during a dinner session of the National Aeronautic Meeting of the Society of Automotive Engineers. The Guggenheim medal is a jointly sponsored award of The American Society of Mechanical Engineers, the Institute of the Aeronautical Sciences, and the SAE. Mr. Howe delivered a "Progress Report on Canadian Aviation" as principal speaker of the evening.

ASME to Join First EJC General Assembly in New York, N. Y., Jan. 21, 1955

THE Engineers Joint Council, for the first time in its history, will hold a general assembly and a banquet at the Hotel Statler, New York, N. Y., Jan. 21, 1955. The day-long program is designed to include discussions of the major topics of importance to the engineering profession.

The basic theme of the assembly will be the increase of unity in the engineering profession. In addition to the wide variety of topics to be covered in committees and papers by leaders in the profession, there will be addresses by distinguished authorities at luncheon and dinner. Featured for the evening portion of the program is the installation of new officers.

Discussions will deal with the problem of engineering-manpower shortage, employment conditions as they affect engineers, the national water policy which has occupied the Council's attention for several years, activities in specialized areas of engineering such as in the industrial and peacetime phases of nuclear development, and finally, the future usefulness of EJC to affiliate and associate societies.

Thorndike Saville, dean of engineering at New York University, is president of the Council.

The constituent societies of EJC are the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Water Works Association, American Institute of Electrical Engineers, Society of Naval Architects and Marine Engineers, American Society for Engineering Education, American Institute of Chemical Engineers.

O. L. Lewis, *left,* chairman, ASME Petroleum Division, presents certificate of appreciation for outstanding service to S. Mensonides at the banquet, September 28. *Center photo* shows D. P. Thornton, Jr., Southwestern editor, *Petroleum Processing,* who was among others to receive a certificate. W. L. Dugan, *right,* holds Student Paper award which he received for a petroleum paper he wrote as a senior at Stevens Institute of Technology.

ASME Los Angeles Petroleum Mechanical-Engineering Meeting Great Success

The ninth annual Petroleum Mechanical-Engineering Conference, held September 26–29 in the Statler Hotel, Los Angeles, Calif., under the sponsorship of The American Society of Mechanical Engineers, was the most successful technical meeting of petroleum engineers ever held on the West Coast, according to L. F. Strader, Richfield Oil Corporation and conference chairman.

Nearly 700 engineers registered for the four-day meeting which featured 36 technical papers at 18 technical sessions. "The large attendance, the high quality of the papers, and the unprecedented demand for preprints indicate the emergence of the Southern California area as one of the nation's foremost centers of petroleum-engineering interest and activity," Mr. Strader said.

Technical Program

The technical sessions covered important phases of petroleum refining, production, materials, manufacturing, and transportation. Speakers and chairmen included national industrial leaders from all sections of the country.

Delivering the conference welcome address at a luncheon session September 27, Eugene W. O'Brien, past-president and Fellow ASME, told the assembled engineers that, "Human relations play a more important part in engineering success than technical qualities."

Mr. O'Brien recently concluded a study in which he interviewed 800 recent engineering graduates. "Of 541 pertinent replies, more than 300 listed human-relations factors as the key to their professional success," Mr. O'Brien said. He called for a re-evaluation of engineering education to give added stress to these factors.

A high spot of the convention was a banquet address by Joseph Jensen, assistant to the divisional general manager of the Western Division, Tidewater Associated Oil Company, and chairman of the board of directors of the Metropolitan Water District of Los Angeles. Mr. Jensen reported on coming water needs of the Southern California area.

Eugene Biscailez, *left,* Sheriff of Los Angeles, Calif., extends official welcome to the 1954 Petroleum Mechanical-Engineering Conference audience. Eugene W. O'Brien, *center,* past-president ASME, discusses human relations as a factor in engineering. Joseph Jensen, *right,* addresses the Petroleum banquet on water supply for Southern California's industries.

"Southern California population, increasing at the rate of 274,000 per year and expected to reach 10 million by 1980, poses the need for ever-greater quantities of water," Mr. Jensen said. "To meet growing water requirements, the Metropolitan Water District has already spent more than $216 million on construction to supply water needs of 60 southland cities." He added that Southern California will win its long-standing water dispute with Arizona.

Award Certificates

At the banquet, certificates of appreciation were awarded to nine former ASME Petroleum Division chairmen. O. L. Lewis, national chairman of the Petroleum Division, presented award certificates for outstanding service and achievement to: Max P. Watson, United Gas Pipe Line Company, New Orleans, La.; T. B. Tuttle, equipment editor, *The Oil & Gas Journal*, Tulsa, Okla.; David P. Thornton, Jr., Southwestern editor of *Petroleum Processing*, Houston, Texas; Winfred H. Stueve, consulting engineer, Oklahoma City, Okla.; L. F. Strader, assistant vice-president of manufacturing, Richfield Oil Corporation, Los Angeles, Calif.; S. Mensonides, vice-president and general sales executive, Farrar & Trefts, Buffalo, N. Y.; D. E. Fields, vice-president, Fliat Steel Corporation, Tulsa, Okla.; C. R. Draughon, Esso Standard Oil Co., New Orleans, La.; and F. J. Daasch, Rock Island, Ill.

W. L. Dugan, presently of the Hughes Tool Company, was awarded a Student Paper certificate and cash prize for his paper on petroleum engineering, which he submitted during his senior year at Stevens Institute of Technology.

High light of the technical papers was a prediction by Roger Gilliland, The Swartwout Company, Alhambra, Calif., that "automated" petroleum production is fast approaching. "The change-over from electrical or manual controls in the petroleum and chemical industries will lower installation and production costs," he said, "and bring about the installation of electronic computers, that are already changing the shape of other industries."

Inspection Trips

Inspection trips were arranged to include a boat tour through the facilities of Long Beach Harbor located over one of the largest producing oil fields in California. This harbor ranks with the most modern in the United States.

On Tuesday the Richfield Oil Corporation Watson Refinery was visited where a forty-million-dollar expansion and modernization program has just been completed.

Two trips were scheduled for Wednesday, the Brea Chemical Company Ammonia Plant, and Union Oil Company Research Center.

Availability List for 1954 ASME Petroleum Mechanical-Engineering Conference Papers

The papers in this list are available in separate copy form until July 1, 1955. Please order only by paper *number;* otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Paper No.	*Title and Author*
54—PET-1	The American Standard Code for Pressure Piping, by F. S. G. Williams
54—PET-2	Mechanical Features of the Hyperforming Process, by Clyde Berg
54—PET-3	Design Problems and Applications of High-Speed Turbines, by H. Steen-Johnson
54—PET-4	Field Co-Ordinating Organization for Improving Efficiency of Petroleum-Refinery Maintenance, by E. C. Hermann
54—PET-5	Field-Welding of Heavy-Wall Pressure Vessels, by F. A. Upson
54—PET-6	Allowable Membrane Stresses for Welded Carbon-Steel Boilers and Pressure Vessels, by W. P. Kerkhof
54—PET-7	Stresses From Local Loading in Cylindrical Pressure Vessels, by P. P. Bijlaard
54—PET-8	The Circular-Girder Four-Columns Space Frame, by N. A. Weil and J. S. Podolan
54—PET-9	A Look Ahead in Pressure-Vessel Design in the Petroleum Industry, by E. W. Jacobson
54—PET-10	Handling Viscous Crude Oils by Pipe Line, by Morgan Martin
54—PET-11	A Damper for Wind-Induced Bridge-Vibration Experimental Studies, by R. C. Baird and A. J. Ebersole
54—PET-12	Wind-Induced Vibration of a Pipe-Line Suspension Bridge and Its Cure, by R. C. Baird
54—PET-13	In-Situ Combustion-Oil Recovery Process—Installation for Field Experiment in Jefferson County, Okla., by R. L. Koch, J. F. Gleason, Jr., and W. G. Boston
54—PET-14	Techniques Developed in the Testing of Reinforced Polyester Pipe, by H. D. Boggs and D. R. Longnecker
54—PET-15	The Development of a Rubber-Sealed Valve For Oil-Well Drilling, by L. H. Carr
54—PET-16	Principles of Duplex Slush-Pump Operation, by R. L. Walker and R. A. Tappmeyer
54—PET-17	Adapting Radiography to Petroleum-Industry Needs, by H. Hovland
54—PET-18	Glass Coating as a Corrosion Barrier, by W. A. Deringer
54—PET-19	The Design of Offshore-Drilling Structures, by R. J. Howe
54—PET-20	Resistance of Tubular Materials to Sulphide Corrosion Cracking, by J. P. Fraser and R. S. Tressider
54—PET-21	Electric-Arc Technique for Stub-Ending Drill Collars, by W. S. Bachman
54—PET-22	Bottom-Hole Pressure Surges While Running Pipe, by E. H. Clark, Jr.
54—PET-23	Free-Piston Gas-Turbine Prime Mover, by R. P. Ramsey
54—PET-24	Power Actuation of Flow Valves for Automation of Lease Operations, by A. A. Toben
54—PET-25	Excavated Underground Storage for Petroleum Products, by R. L. Loofbourow
54—PET-27	Hydrogen Blisters in Gas Transmission Lines and Preventive Methods, by Felipe Paredes and W. W. Mize
54—PET-28	The Application of V-Belt Drives to Slush Pumps, by W. S. Worley
54—PET-29	Economics of Design of Heat Exchangers, by E. D. Anderson and E. W. Flaxbart
54—PET-30	Electronic Automatic-Control System as Applied to the Petroleum Industry, by Roger Gilliland
54—PET-31	The Use of Electronic Digital Computers in Pipe-Line Design and Operation, by T. Y. Hicks and G. V. Rohleder
54—PET-32	Report on the Protection of Offshore Steel Structures by a Metallurgical Method, by B. B. Morton
54—PET-33	Mechanical Advancement in the Alkylation Process, by S. R. Stiles
54—PET-34	Economics and Operating Procedure of Crude-Oil Tank Mixers, by Neil G. Wilson
54—PET-35	The Influence of High-Strength Materials on the Design and Fabrication of Layer Vessels, by G. E. Fratcher

Success of First ASME-ASLE Lubrication Conference Encourages Plans for Future

The two-day conference held jointly by the American Society of Lubricating Engineers and the Lubrication Activity of The American Society of Mechanical Engineers was the first such undertaking.

Meeting in Baltimore, Md., at the Lord Baltimore Hotel, October 18 and 19, this combined group project made giant strides toward establishing a general forum where engineers directly concerned with lubrication problems could present and discuss their findings and views.

More than 300 engineers attended the first conference. Nineteen papers were presented covering the general phases of friction and lubrication. The session subjects included the following: Hydrostatic lubrication—the papers pertained to hydrostatic journal,

thrust, and spherical bearing; bearing instability—whip and whirl in journal bearings, and turbulence in thrust bearings; new developments in hydrodynamic lubrication—recent advances in the hydrodynamics of slider bearings, cam and cam followers, and noncircular section sleeve bearings; rolling-element bearings—high-speed ball-and-roller-bearing operation, high-temperature ball-bearing operation in the absence of a lubricant, and materials and lubricants, gear materials; temperature and pressure—viscosity effects of oils; and friction research.

The papers covered both the theoretical and practical aspects of the new developments in the field. Conference registrants were presented with a complete set of meeting papers.

The thought-provoking papers and the interest and enthusiasm of the large audience marked the success of the meeting. The program was designed so that no two sessions conflicted, thus affording everyone an opportunity to attend all the meetings.

Plans are in progress for the second annual lubrication conference predicated on the success of the first conference.

Availability List for 1954 ASME-ASLE Lubrication Conference Papers

THE papers in this list are available in separate copy form until August 1, 1955. Please order only by paper *number;* otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Paper No.	*Title and Author*
54—LUB-1	An Analysis of Recent Data on the Effects of Pressure and Temperature on the Viscosity of Lubricants. Part 1—Paraffinic and Naphthenic-Base Oils, by R. B. Dow
54—LUB-2	The Statistical Nature of Friction, by E. RABINOWICZ, B. G. RIGHTMIRE, C. E. TRDHOLM, and R. E. WILLIAMS
54—LUB-3	Investigation of Translatory Fluid Whirl in Vertical Machines, by G. F. BOEKER and B. STERNLICHT
54—LUB-4	Oil-Film Whirl—An Investigation of Disturbances Due to Oil Films in Journal Bearings, by B. L. NEWKIRK and J. F. LEWIS
54—LUB-5	The Short-Bearing Approximation for Plain Journal Bearings, by G. B. DuBOIS and F. W. OCVIRK
54—LUB-6	Friction in a Close-Contact System, by WALTER CLAYPOOLE
54—LUB-7	Turbulence in a Tilting-Pad Thrust Bearing, by STANLEY ABRAMOVITZ
54—LUB-8	Behavior of Air in the Hydrostatic Lubrication of Loaded Spherical Bearings, by T. L. COREY, H. H. ROWAND, JR., E. M. KIPP, and C. M. TYLER, JR.
54—LUB-9	Power Loss in Elliptical and Three-Lobe Bearings, by OSCAR PINKUS
54—LUB-10	Studies in Lubrication (10). The Complete Journal Bearing With Circumferential Oil Inlet, by M. J. JACOBSON, A. CHARNES, and E. SAIBEL
54—LUB-11	On the Solution of Reynolds Equation for Slider-Bearing Lubrication (9). The Stepped Slider With Adiabatic Lubricant Flow, by F. OSTERLE, A. CHARNES, and E. SAIBEL
54—LUB-12	Materials and Designs of Cages for High-Speed Cylindrical Roller Bearings, by W. J. ANDERSON and Z. N. NEMETH
54—LUB-13	Hydrodynamic Lubrication of a Cam and a Cam Follower, by ROBERT DAVIES
54—LUB-14	A Progress Report on the Surface-Endurance Limits of Engineering Materials, by G. J. TALBOURDET
54—LUB-15	Recent Advances in the Hydrodynamic Theory of Slider-Bearing Lubrication, the Reynolds Equation, by F. OSTERLE and E. SAIBEL
54—LUB-16	A Demonstration of Bingham-Type Flow in Greases, by H. E. MAHNCKE and W. TABOR

Meetings of Other Societies

Dec. 12–15
American Institute of Chemical Engineers, annual meeting, Hotel Statler, New York, N. Y.

Dec. 17
Institute of the Aeronautical Sciences, 18th Wright Brothers Lecture, U. S. Chamber of Commerce Building Auditorium, Washington, D. C. To be repeated Dec. 20, Los Angeles, Calif., Dec. 22, Cleveland, Ohio

Dec. 26–31
American Association for the Advancement of Science, 121st meeting, University of California, Berkeley, Calif.

(*ASME Calendar of Coming Events, see page 1050*)

ECPD Revises Booklet on Engineering

AVAILABILITY of a second edition of its popular career-guidance pamphlet for engineers is announced by the Engineers' Council for Professional Development. "Entitled Engineering—A Creative Profession," the 31-page illustrated bulletin clearly and graphically explains just what engineering is; patterns common to all fields of engineering; the necessary educational background; how to go about getting an engineering job; the difference between the various fields of engineering; and the proper choice of a college as the starting point in a professional career. A two-page bibliography of recommended reading is included.

Copies of the pamphlet sell for 25 cents, with a 40 per cent discount available on orders of 50 or more copies. Inquiries should be sent to ECPD, 29 West 39th Street, New York 18, N. Y.

Senator Ralph E. Flanders, *seated*, past-president and Hon. Mem. ASME, U. S. Senator from Vermont, signs the Honorary Members' Book of The Institution of Mechanical Engineers in London, England, during his recent visit. Senator Flanders was elected to Honorary Membership in the Institution, January, 1951, in recognition of his distinction in the practice and organization of engineering. Standing, *left* and *right*, are Dr. S. F. Dorey, who was president of the Institution at the time of the Senator's election, and Dr. R. W. Bailey, president of the IME.

Shown at the Fuels Conference banquet, in Pittsburgh, Pa., October 28, *in center photo,* is P. H. McCance, president, Duquesne Light Company, Pittsburgh, Pa., who was toastmaster; and *right photo,* R. L. Ireland, chairman of the Executive Committee, Pittsburgh Consolidation Coal Company, delivering his talk, "A Look From Within the Coal Industry"; *left photo,* Maurice D. Cooper, *right,* director of mining education, National Coal Association, presents the Percy Nicholls Award to John F. Barkley, Fellow ASME, staff adviser of Fuels and Explosives Division, U. S. Bureau of Mines, Washington, D. C.

ASME-AIME Fuels Conference Is Again a Stand-Out Affair

THE seventeenth annual joint conference of the Fuels Division of The American Society of Mechanical Engineers and the Coal Division of the American Institute of Mining and Metallurgical Engineers was held at the William Penn Hotel, Pittsburgh, Pa., Oct. 28 and 29, 1954.

More than 250 ASME members registered for the two-day conference and the attendance grew to huge proportions on Friday, October 29, when 730 registered for the ninth annual "Off-the-Record" meeting of the Pittsburgh Section AIME, which ran concurrently with the final sessions of the Fuels Conference.

Presidents Welcome Guests

Lewis K. Sillcox, ASME President, and L. F. Reinartz, AIME President, welcomed members and their guests at the opening luncheon of the Fuels Conference. Dr. Sillcox spoke on the early history of ASME and Mr. Reinartz told of the various AIME activities. In the course of his talk he enumerated the many reasons why a young man should join a professional engineering society and the benefits he might expect to derive and stressed the need of interesting intelligent high-school boys in engineering.

In addition to business and dinner meetings, there were 11 technical sessions held at which 39 technical papers or discussions were presented.

Conference Banquet

"The future outlook for the area's coal industry is bright," according to R. L. Ireland, chairman of the Executive Committee, Pittsburgh Consolidation Coal Company, Cleveland, Ohio, principal speaker at the ASME banquet on Thursday.

In his talk entitled "A Look Within the Coal Industry," Mr. Ireland told of the bright outlook for the area's coal industry and added that his industry expects no difficulty in finding a ready market for the area's vast supply of unmined coal, estimated at nearly five-billion tons in eight Western Pennsylvania counties alone.

The coal executive predicted that an expanding utility business will find increasing need for larger supplies. He acknowledged that ills have beset the industry within the past few years, but he added he believed coal is still in the frontier stage and that research holds the key to future expansion.

Mr. Ireland pointed out the need for more engineers of all types to step up coal research and eliminate such problems as smoke and air pollution. He expressed the belief that conquering the difficulties which have cut down coal's traditional markets rather than finding

T. E. Purcell, *left,* Fellow ASME, chairman of the General Arrangements Committee, seventeenth annual ASME-AIME Fuels Conference, Pittsburgh, Pa., Oct. 28–29, 1954, registers L. F. Reinartz, *center,* AIME President, and L. K. Sillcox, *right,* President and Hon. Mem. ASME, for the two-day meeting.

all new markets was the answer to the industry's present blight.

He blamed much of the industry's trouble to overproduction during World War II when strip mines were rushed into operation to supply suddenly increased demands for coal. These mines are still operating and take a share of the coal market which formerly went to deep-mine operators. Mr. Ireland said he believed that production from strip mines should be curtailed in order to reserve it for future emergencies.

P. H. McCance, president of the Duquesne Light Company, Pittsburgh, Pa., served as toastmaster at the banquet.

Percy Nicholls Award

The Percy Nicholls award which is given for outstanding contributions in the coal industry was awarded at the banquet to John F. Barkley, Fellow ASME, staff adviser of the Fuels and Explosives Division, U. S. Bureau of Mines, Washington, D. C. The presentation was made by Maurice D. Cooper, director of mining education, National Coal Association.

Mr. Barkley was honored for his work on the Model Smoke Law Committee; his technical papers on fuels, combustion, and the abatement of air pollution; his practical direction which brought about high efficiencies and fuel savings in many U. S. Government plants; and his much-sought-for and freely given advice.

T. E. Purcell, Fellow ASME, general superintendent of power stations, Duquesne Light Company, was chairman of the General Arrangements Committee and a large portion of the success of the seventeenth Fuels Conference is attributed to his enthusiastic and energetic direction of the various and several committees.

Eighteenth Fuels Conference

The eighteenth annual Fuels Conference will be held at the Neil House, Columbus, Ohio, Wednesday and Thursday, Oct. 19 and 20, 1955. Elmer Kaiser will be chairman of the 1955 Conference Committee, with William T. Reid as co-chairman. Other chairmen of the 1955 committees are: A. B. Clymer, *Publicity;* J. R. Garvey, *Plant Trips;* G. E. Haney, *Printing and Signs;* W. C. Holton, *Technical;* C. J. Lyons, *Registration;* J. H. Melvin, *Finance;* J. M. Pilcher, *Entertainment;* and M. L. Smith, *Hotel.*

Availability List for 1954 ASME-AIME Fuels Conference Papers

The papers in this list are available in separate copy form until August 1, 1955. Please order only by paper *number;* otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Paper No.	*Title and Author*
54—FU-1	Air-Pollution-Control Problems With Heat Drying of Fine Coal, by C. W. Gordon
54—FU-2	Progress Report: Bureau of Mines Estimate of Coking-Coal Reserves, by J. J. Dowd
54—FU-3	Small and Medium-Sized Cyclone-Furnace Boilers, by W. I. Collins
54—FU-4	Performance of Chain and Traveling-Grate Stokers Burning Coals Mined in the Pittsburgh District of Pennsylvania, by J. M. MacLachlan

ASME and IEC Prime Movers Committees Meet in Philadelphia, Pa.

The work of The American Society of Mechanical Engineers on power test codes has not been confined only to national standardization but has played an important part also in international standardization to the end that buying and selling of prime movers between nations might be facilitated. Through its membership in the International Electrotechnical Commission since 1925, the ASME has been actively engaged in bringing about international agreements covering specifications and acceptance tests for this type of equipment. The U. S. National Committee of the IEC accepted the secretariats for the three international committees on prime movers. The work of the IEC, interrupted during the second world war, has gradually been reactivated since July, 1946, and the programs of the prime-movers committees were resumed and sufficiently advanced to have these technical committees meet during the Golden Jubilee of the IEC in Philadelphia, Pa., at the University of Pennsylvania, during the two weeks of Sept. 1-16, 1954.

Following are brief statements of the activities relating to hydraulic turbines, steam turbines, and internal-combustion engines.

Hydraulic Turbines

IEC/TC/4 on Hydraulic Turbines met for three days, September 1-3, with representatives of nine countries participating: Canada, France, Germany, Japan, Sweden, Switzerland, United Kingdom, Yugoslavia, and the United States.

There was unanimous agreement on the urgent need for an international code covering rules for acceptance tests for hydraulic turbines. Three documents were under consideration at the meeting and included: 1 Swiss Rules for Hydraulic Turbines, 2 ASME Power Test Code for Hydraulic Prime Movers, and 3 Tentative Draft of Proposed United States Current Meter Method of Testing.

In the course of their deliberations the committee discussed three methods of water measurement, namely, current meters, Allen salt velocity, and Gibson (pressure time). It was voted unanimously to include these three methods in a recommended IEC Code on Hydraulic Turbine Testing in conjunction with proper provisions for the application of each method on the understanding that this implies no restrictions as to the inclusion of other methods of water measurement.

After having discussed the problem of tolerances, the delegates of seven countries (France not voting) voted to include:

1 A plus-tolerance only in output to take into account the unavoidable variations in manufacture and construction.

2 Plus and minus tolerances on measured efficiencies with respect to the inaccuracies inherent in measurements, with the understanding that the manner of application and the amount of these tolerances would be decided at a later date.

It also was recognized that information on windage and friction has been very meager in the past. However, discussions at the meeting indicated that further information is now becoming available. Action by the Committee empowered the permanent chairman of IEC/TC/4, S. Logan Kerr, Fellow ASME, to appoint a committee to study and correlate all available data on the subject from which suitable formulas can be derived for the consideration of the technical committee for inclusion in an international test code for hydraulic turbines.

The Secretariat will prepare a proposed draft of a code for the consideration of IEC/TC/4 on Hydraulic Turbines.

Steam Turbines

IEC/TC/5 on Steam Turbines held four days of meetings—September 7, 8, 10, and 11, with representatives of ten countries present: Canada, Belgium, France, Germany, India, Italy, Sweden, Switzerland, United Kingdom, and the United States.

The three secretariat documents relating to steam turbines presented for discussion and consideration covered:

1 Part 1, the Purchase Specification (proposed revision of IEC Publication 45)

2 Part 2, Rules for Acceptance Tests (proposed revision of IEC Publication 46)

3 Appendix to Rules for Acceptance Tests (revision of IEC Publication 46A, Supplementary Notes on Instruments and Methods of Measurement)

Referring to part 1, the Purchase Specification, after the Secretariat has incorporated the comments and suggestions made at this meeting, the proposed revision of this international document will be submitted to all IEC National Committees for ratification under the "Six Months' Rule."

The general views expressed by the delegates during the meeting will be incorporated by the Secretariat into further revisions of part 2, Rules for Acceptance Tests, and the Appendix to the Rules Covering Supplementary Notes on Instruments and Methods of Measurement. After sufficient time has been allowed for review of these revised documents by the national committees forming IEC/TC/5, another meeting will be scheduled.

It was agreed that for the present the Rules for Acceptance Tests will only provide for the

conduct of tests and for the computation of the results for turbines of the following types:

(*a*) Complete expansion condensing turbines in which all the steam enters at one pressure and all the steam leaves at a pressure less than that of the atmosphere.

(*b*) Condensing turbines similar to (*a*) except that the steam is reheated after partial expansion.

(*c*) Condensing turbines similar to (*a*) but operating on a regenerative cycle, i.e., steam being extracted from one or more stages solely for heating the unit's own feedwater. This class may include turbines that supply extraction steam for heating make-up feedwater, also evaporators and deaerators serving as extraction feedwater heaters.

(*d*) Condensing turbines similar to (*a*) but provided with both the special features described in (*b*) and (*c*).

(*e*) Noncondensing and back-pressure turbines in which all steam enters at one pressure and all steam leaves at a pressure equal to or greater than that of the atmosphere.

Additional types of turbines will be considered at the next meeting of the committee.

In order to determine the desirability of including numerical examples of the various calculations which are specified in the Rules, copies of the Appendix to the ASME Power Test Code for Steam Turbines that covers such items will be sent to the delegates for their study, consideration, and comment.

Since consideration of the future development and definition of the 50-cycle preferred standard for condensing steam turbines is required, IEC/TC/5 recommended that its Subcommittee 5A on Turbo-Generator Sets schedule a meeting in London, England, in 1955, to discuss these problems.

Subject to prompt co-operation from the national committees relative to the work of the Secretariat, it is believed that the next meeting of IEC/TC/5 can be convened in approximately two years at a suitable location.

Internal-Combustion Engines

IEC/TC/19 on Internal-Combustion Engines was in session for two days—September 14 and 15. Since only four countries were represented—France, Germany, Italy, and the United States—it was agreed to discuss informally the problems at hand. International purchase specifications for internal-combustion engines had been adopted in 1939. While the rules for acceptance tests and the information on instruments and apparatus were circulated for comment, approval was not obtainable due to the war. Revisions of these documents, therefore, were prepared by the Secretariat and distributed prior to this meeting. An additional document was introduced to the meeting covering specifications for reciprocating internal-combustion engines (excluding carburetor type) as representing the current thinking of the United States delegation. In the time available discussion was limited to this latter document which will be revised by the Secretariat and distributed to the members of IEC/TC/19 for consideration.

A New Frontier—Air-Pollution Control; ASME International Air-Pollution Meeting Theme

The high light of the First International Congress on Air Pollution based on the theme: "A New Frontier—Air-Pollution Control," sponsored by The American Society of Mechanical Engineers, to be held in the Hotel Statler, New York, N. Y., on March 1–2, 1955, will be the presentation of the Calvin W. Rice Lecture by Sir Hugh E. C. Beaver, chairman of the Government Committee of Enquiry investigating the disastrous London, England, smog of 1952 which killed 4000 persons.

The meeting, first of its kind in the world, will be one of the special features celebrating the 75th Anniversary of the Society, which held its first meeting in New York in November, 1880. Since the Donora, Pa., disaster of 1948 and the great London smog of 1952, public interest in the subject of air pollution has grown steadily. The Society, recognizing the need for practical and technical experience to be focused on the problem, formed its Committee on Air-Pollution Controls in 1949.

This activity stemmed from earlier work by an ASME group which culminated in the publication of its model smoke law which forms the basis for most municipal ordinances on the subject.

The 1955 International Congress is further recognition by ASME of the changing trends in the problem. Distinguished experts from all parts of the world will gather in New York to discuss the latest developments in the control of the air-pollution problem.

Technical Program

Among the topic sessions will be "Gaps in Our Knowledge of Air Pollution," discussed from the points of view of engineering, biology, meterology, administration, and effects upon vegetation; also, "The Role of Sulphur Gases in Air Pollution," with speakers on the economics of sulphur, experimental studies of stack gases, and recovery of sulphur in the petroleum, power, iron and steel, and chemical industries.

L. B. Hein of the Tennessee Valley Authority will speak on "Recovery of Sulphur Dioxide From Coal-Combustion Stack Gases: Pilot-Plant Studies of an Ammonia Scrubbing Process." From the British Electricity Authority, R. L. Rees, chief chemist, will discuss "The Removal of Sulphur Dioxide From Power-Plant Stack Gases." A representative of the Freeport Sulphur Company will present a paper on the world supply of sulphur, the exhaustion of which will affect the economic practicability of recovery from stack gases. G. E. Smalley and J. W. Klohr of The Ralph M. Parsons Company, have accepted an assignment on sulphur recovery from hydrogen sulphide-acid gases.

Calvin W. Rice Lecturer

Sir Hugh Beaver, who is managing director of Arthur Guinness, Son & Co., Ltd., has held many responsible appointments, aiding the government in the study of special problems, among them "new towns" and "Building Industry Working Party." He has also held the offices of Director General and Controller General of the Ministry of Works. His new assignment, which came in 1953, poses the enormous task of coming up with an answer to the cause and control of London smogs. The 1952 episode, which began on December 5 of that year, killed an estimated 4000 Londoners and sickened and distressed many more. The full significance of this catastrophe was not immediately realized and Sir Hugh's committee was not appointed until July, 1953. The vigor of his attack is evidenced by the publication of a useful interim report before the end of that year. A final report is expected by the end of this year or early in 1955 and will form the basis of the lecture by Sir Hugh at the ASME meeting in March.

Sir Hugh E. C. Beaver

The Calvin W. Rice Lecture was awarded Sir Hugh by the ASME in recognition of his many outstanding achievements in the engineering field. Created to honor the man who was ASME secretary from 1906 to 1934 and to further his ideals to increase understanding between the engineers of the various countries and to broaden the programs of Society meetings, the lecture has been awarded to distinguished engineers each year since 1934.

ASME Membership as of October 31, 1954

Honorary Members	56
Fellows	393
Members	14,369
Affiliates	314
Associate Members (33 and over)	3,604
Associate Members (30–32)	3,169
Associate Members (to the age of 29)	17,978
Total	39,883

Hoover Medal Awarded to Alfred P. Sloan, Jr.

At the annual dinner of the American Institute of Consulting Engineers, held October 19, at the Waldorf-Astoria Hotel, New York, N. Y., Scott Turner, AICE president, presented the Hoover Gold Medal for 1954 to Alfred P. Sloan, Jr.

Mr. Sloan, chairman of the board of General Motors since 1937, and fifteenth recipient of the medal, was honored as:

"Engineer; builder of vast industry, friendly co-ordinator of management and labor; generous supporter of research in economics, education, and medicine; eminent citizen, exemplifying the finest traditions of American free enterprise."

Mr. Sloan is president of the Alfred P. Sloan Foundation, which has contributed to a number of colleges and universities. The foundation made possible the Sloan-Kettering Institute for Cancer Research, a component of Memorial Cancer Center, of which he is manager.

The Hoover Gold Medal, awarded by engineers "to a fellow engineer for distinguished public service," was founded 25 years ago. It is presented through a Board of Award composed of three representatives of each of the four Founder Societies. The medal was named in honor of Herbert Hoover, Hon. Mem. ASME, who was its first recipient in 1930 while he was President of the United States, on the occasion of the Fiftieth Anniversary Meeting of The American Society of Mechanical Engineers, held in Washington, D. C., that year.

Mr. Hoover was also a guest of honor at the AICE dinner, at which time he received the Institute's Award of Merit. The award has been made only twice before in the 44-year history of the Institute—in 1952 to C. H. Howe, Hon. Mem. ASME, Minister of Trade and Commerce of Canada, and in 1953 to Vannevar Bush, president of the Carnegie Institution, Washington, D. C.

ASME Casts Ballots for Amendments to Constitution and By-Laws

As reported by the tellers of Amendments to the Constitution, George E. Hagemann, Glenn R. Fryling, and Adolf Ehbrecht, letter ballots received from members of The American Society of Mechanical Engineers were counted on Nov. 10, 1954. The total number of ballots cast was 14,292; of these 115 were thrown out as defective.

	Votes for	*Votes against*	*Not voting*
1 Grant Council Authority to Remit Initiation Fees (Modification of Article C5, Sec. 4)	13,695	452	30
2 Change in Council Organization (Modification of Article C6, Sec. 2, and Article C7, Sec. 4)	13,419	641	117
3 Increase Nominating Committee from 8 to 11 (Modification of Article B7, Par. 1)	10,668	3,379	130

Alfred P. Sloan, Jr., *left*, receives the Hoover medal at the annual dinner of the American Institute of Consulting Engineers, held in New York, N. Y., October 19. Presentation was made by Scott Turner, president AICE.

ERNEST HARTFORD

Ernest Hartford has retired as deputy secretary of The American Society of Mechanical Engineers after 43 years of service to the Society. He will continue to serve the Society in a consulting capacity.

ASME Teams With ECPD to Discuss "First-Five-Years Program" at Cincinnati

The twenty-second annual meeting of Engineers' Council for Professional Development was held at the Hotel Alms, Cincinnati, Ohio, Oct. 28 and 29, 1954. The choice of location had been made in order that members of ECPD and their guests might have an opportunity to observe at firsthand the operation of the plan for the training of young engineers initiated in that city a year ago and popularly known as the first five years of professional development.

The ECPD annual meeting affords opportunity for the presentation and discussion of the reports of ECPD chairman and committees, to conduct the business of the Council and particularly to act upon recommendations of the Education Committee on accreditation of engineering curriculums and programs of the technical-institute type, for the election of officers, for individual committee meetings, and for the association of members of the Council and engineers and educators interested in ECPD.

In addition to the formal program of reports and committee meetings, the social events included two luncheons and a banquet, a women's program, and a visit to the plant of the Cincinnati Milling Machine Company which is celebrating its seventieth anniversary this year.

Social Events

At the luncheon on Thursday, C. A. Harrell, member ASCE, City Manager of Cincinnati, spoke on "Civic Responsibilities of the Engineer." Joseph F. Treon, president, Engineering Society of Cincinnati, welcomed the guests to Cincinnati.

With Col. L. F. Grant (Engineering Insti-

tute of Canada), chairman of ECPD, presiding at the Friday luncheon, Francis J. Curtis, member AIChE, vice-president and director, Monsanto Chemical Company, St. Louis, Mo., delivered an address entitled "What Industry Expects of the Young Engineer in the First Five Years."

The annual dinner, which followed a cocktail hour, was the occasion for the presentation of the annual report of the chairman of ECPD, Col. L. F. Grant. Greetings from Raymond Walters, president, University of Cincinnati, were graciously delivered, and past-chairmen, presidents of participating societies, and representatives of local engineering societies present were recognized by M. D. Hooven, member AIEE, vice-chairman, ECPD, who presided. The address was delivered by James H. Taylor, assistant director for manpower, Office of Defense Mobilization, and director of industrial relations, The Procter and Gamble Company.

Annual Reports of ECPD Committees

The afternoon session on Thursday was given over to the presentation of the annual reports of the standing committees on Guidance, Education, Student Development, Recognition, Ethics, and Information. All reports were preprinted and copies are available.

Friday morning was the occasion of the presentation of the report of the ECPD Training Committee, presented under the title, "A Community Project in Professional Development," by the chairman of the committee, Cornelius Wandmacher, head, department of civil engineering, University of Cincinnati. The pilot project of the Training Committee was instituted at Cincinnati under the guidance of Professor Wandmacher who had been closely associated with the original plan as presented at Cleveland, Ohio, in 1950, by the Committee then headed by A. C. Monteith, Hon. Mem. ASME, vice-president in charge of engineering and research, Westinghouse Electric Corporation. After introductory remarks by Mr. Monteith, by Ernest S. Fields, member AIEE, chairman of the Cincinnati sponsor group, and Walter A. Draper, member ESC, president, Herman Schneider Foundation, Cincinnati, a panel discussion of the subject, "Orientation and Training in Industry as Related to the 'First-Five-Years Program,'" occupied the time remaining before luncheon.

In the afternoon two additional panel discussions, running concurrently, were provided for ECPD members and guests, one on "Engineering Societies and the 'First-Five-Years Program'" and the other on "Engineering Colleges and the 'First-Five-Years Program.'" Later in the afternoon "Community Projects in Professional Development, Present and Projected" were presented by representatives from Detroit, Mich.; Hamilton, Ont., Can.; Atlanta, Ga.; and Tulsa-Bartlesville, Okla.

Officers Elected

The newly elected officers of the Council were announced at the meeting. New titles were adopted at the meeting for the chairman and vice-chairman; in the future the titles will be president and vice-president.

The officers are: L. F. Grant, EIC, president; M. D. Hooven, AIEE, vice-president; S. L. Tyler, AIChE, secretary; and W. N. Carey, ASCE, assistant secretary.

To serve as chairmen of the standing committees of ECPD the following selections were made public: S. Paul Shackleton, Guidance Committee; H. L. Hazen, Education Committee; N. W. Dougherty, Student Development Committee; E. L. Yates, Training Committee; R. G. Warner, Recognition Committee; Scott Turner, Ethics Committee; and J. B. Mellecker, Information Committee.

ASME representatives to the Council include: W. F. Ryan, Henry N. Meixner, and A. C. Monteith.

ASME Calendar of Coming Events

Feb. 16, 1955
The Founding Anniversary Meeting, McGraw-Hill Building, New York, N. Y.
(No formal papers will be presented)

March 23–24, 1955
ASME Management Conference, Hotel Statler, Cleveland, Ohio
(Final date for submitting papers was Nov. 1, 1954)

April 6, 1955
ASME Machine Design Division Conference, as part of the Centennial Celebration, New York University's college of engineering

April 16, 1955
The Organization Anniversary Meeting, Stevens Institute of Technology, Hoboken, N. J.
(No formal papers will be presented)

April 18–21, 1955
Diamond Jubilee Spring Meeting, Lord Baltimore and Southern Hotels, Baltimore, Md.
(Final date for submitting papers was Dec. 1, 1954)

April 25–26, 1955
ASME Instruments and Regulators Conference, University of Michigan, Ann Arbor, Mich.
(Final date for submitting papers was Dec. 1, 1954)

June 5–10, 1955
ASME Oil and Gas Power Conference, Hotel Statler, Washington, D. C.
(Final date for submitting papers—Feb. 1, 1955)

June 15–17, 1955
ASME and The Institution of Mechanical Engineers, London, England, Joint Conference on Combustion, Massachusetts Institute of Technology, Cambridge, Mass.
(Final date for submitting invited papers was Nov. 1, 1954)

June 16–18, 1955
ASME Applied Mechanics Conference, Renssalaer Polytechnic Institute, Troy, N. Y.
(Final date for submitting papers—Feb. 1, 1955)

June 19–23, 1955
Diamond Jubilee Semi-Annual Meeting, Hotel Statler, Boston, Mass.
(Final date for submitting papers—Feb. 1, 1955)

Sept. 12–16, 1955
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Los Angeles, Calif.
(Final date for submitting papers—May 1, 1955)

Sept. 25–28, 1955
ASME Petroleum-Mechanical Engineering Conference, Roosevelt Hotel, New Orleans, La.
(Final date for submitting papers—May 1, 1955)

Nov. 13–18, 1955
Diamond Jubilee Annual Meeting, Hotel Congress, Chicago, Ill.
(Final date for submitting papers—July 1, 1955)
(For Meetings of Other Societies, see page 1045)

AAAS to Convene in Berkeley, December 28-29

The annual meeting of the American Association for the Advancement of Science will hold its annual meeting at the University of California, Berkeley, December 28 and 29.

The Pacific Southwest Section of the American Society for Engineering Education will hold its winter meeting concurrently with AAAS Section M—Engineering on Wednesday, December 29. At a recent meeting of Section M, C. E. Davies, secretary ASME, was re-elected chairman of the Section and vice-president of the AAAS for 1955, by unanimous vote.

The program to be presented by Section M at the annual meeting is as follows:

MONDAY, DECEMBER 27

9:30 a.m. Room B45 Dwinelle Hall. THE APPRAISAL OF NATURAL RESOURCES DEVELOPMENT; Joint session of the AAAS Sections K (Economics) and M (Engineering); program arranged by Section K.

Economics in Cost-Benefit Analysis for Resources Development, *C. V. Wantrup.*

Current Practices in Cost-Benefits—Analysis for Government and Businesses, *M. M. Kelso*

Public Benefits Gained From Engineering in the Development of Natural Resources, *Frank Baron,* University of California, Berkeley, Calif.

2:00 p.m. Room 125 Hilgard Hall. WATER SUPPLY AND IRRIGATION. Joint session of the AAAS Sections O (Agriculture) and M (Engineering).

4:00 p.m. Wheeler Auditorium; AAAS General Symposium 1—RESOURCES AND ENERGY.

TUESDAY, DECEMBER 28

2:00 p.m. Room 113 Haviland Hall. HIGHWAY SAFETY; Joint session of the AAAS Sections I (Psychology) and M (Engineering); program arranged by T. W. Forbes of Section I.

Attitudes of Traffic Violators, *Harry W. Case.*

Visual Factors in Distance Judgment and Legibility, *George E. Moni.*

The Statistics of Accident Records and Accident Proneness, *Wilse B. Webb.*

Effectiveness of Tests for Safe-Fleet Drivers. *Clark L. Wilson.*

WEDNESDAY, DECEMBER 29

AAAS Section M, Engineering, will meet with the Pacific Southwest Section of the American Society for Engineering Education.

THURSDAY, DECEMBER 30

9:30 a.m. Room 101 California Hall. Symposium on AIR POLLUTION. Part 1. Program developed by Section M (Engineering) and cosponsored by Sections N (Medicine), O (Agriculture), and C (Chemistry). Arranged by L. B. Hitchcock, University of California, president, Southern California Air-Pollution Foundation. L. B. Hitchcock, president, Southern California Air-Pollution Foundation, *presiding.*

Definition of Air Pollution Today in American Cities. *L. B. Hitchcock,* University of California, Berkeley, Calif.
Discussion Leader, *A. M. Zarem,* Stanford Research Institute, Los Angeles, Calif.

Review of Methods of Analysis and Instrumentation—Available and Needed. *Moyer D. Thomas,* Stanford Research Institute, Stanford, Calif.
Discussion Leader, *Wesley C. Merrill,* Union Oil Company, Placentia, Calif.

Available Methods for the Control of Emissions. *Gordon P. Larson,* director, Los Angeles County Air Pollution Control District; president, Air-Pollution Control Association.
Discussion Leader, *Wayne Sproull,* Western Precipitation Corp., Los Angeles, Calif.

10:00 a.m. Room 145 Dwinelle Hall. STATISTICS IN INDUSTRIAL RESEARCH. Third Symposium on MATHEMATICAL STATISTICS AND PROBABILITY. Joint session of the AAAS Sections A5 and M (Engineering). Arranged by H. Scheffe of Section A5.

Applications of Efficient Experimental Designs to Research. *Cuthbert Daniel*, engineering statistician.

New Results on Inspection Sampling by Variables. *Albert Bowker*, Stanford University.

Statistical Problems of Life-Testing Electronic Equipment. *Milton Sobel*, Bell Telephone Laboratories.

2:00 p.m. Room 101 California Hall. Symposium on AIR POLLUTION, Part 2, Session 2. Program developed by Section M (Engineering) and cosponsored by Sections N (Medicine), O (Agriculture), and C (Chemistry). Arranged by L. B. Hitchcock, University of California, Berkeley. *L. B. Hitchcock*, president, Southern California Air-Pollution Foundation, *presiding*.

Vehicle-Combustion Products and Possible Remedies. *W. L. Faith*, Southern California Air-Pollution Foundation.
Discussion Leader, *Lawrence J. Grunder*, Richfield Oil Company, Los Angeles.

Response of Plants to Air Pollution. *John Middleton*, University of California, Riverside, Calif.
Discussion Leader, *Frits W. Went*, Earhart Laboratories, California Institute of Technology, Pasadena, California.

Public-Health Implications of Air Pollution. *John J. Phair*, The Kettering Laboratories, University of Cincinnati, Cincinnati, Ohio.

Scientific Manpower

The fourth Conference on Scientific Manpower, sponsored by the National Science Foundation, the National Research Council, the Engineering Manpower Commission, the Scientific Manpower Commission, and Section M—Engineering of the American Association for the Advancement of Science, will be held at the University of California in Berkeley, Calif., Dec. 28–29.

The first session of the conference will be on "Implications of the Findings of the Commission on Human Resources and Advanced Training." Papers will be presented by Lee A. DuBridge, California Institute of Technology; Conrad Taeuber, Bureau of the Census, and Ralph Tyler, Center for Advanced Study in the Behavioral Sciences, on the implications as they affect the natural sciences, social sciences, and science teaching, respectively. The second session will deal with "Prospective Developments in Utilization of Scientists and Engineers." Raymond Ewell, National Science Foundation, and A. L. Lyman, California Research Corporation, will present papers on the "Estimated Volume of Research and Development Expenditures in 1955 by Government and Industry." Other papers will be presented on "Selective-Service and Military-Reserve Developments."

Scientific Editorial Problems

The third conference on Scientific Editorial Problems will be held December 29 and 30. This conference is a permanent feature of the annual meeting of the AAAS. This year, for the first time, multiple sessions will be held. All sessions will be held in Room 125, Hilgard Hall, on the campus of the University of California at Berkeley. Marian Fineman, chief, editorial branch, Dugway Proving Ground, Dugway, Utah, is chairman.

The program is divided into four sessions, the first three of which, to be presented on Wednesday, cover the preparation of technical manuals for complex instruments, effective technical writing, and scientific journals. The fourth session, scheduled for Thursday, is devoted to the problems of military and industrial technical reports and is cosponsored by the Technical Publishing Society.

At presentation of Standards Engineers Society award to The Honorable Herbert Hoover are, *left to right*, Stan Zwerling, Armed Services Electro Standards Agency, chairman of SES Awards Committee; Mr. Hoover; Madhu S. Gokhale, RCA Victor Division, SES vice-president; W. L. Healy, General Electric Company, SES president; Herbert G. Arlt, Bell Telephone Laboratories, chairman, New York Section; Vice-Admiral G. F. Hussey, Jr., USN, Ret., managing director, American Standards Association, who was also honored.

Standardization Saves American Taxpayers Millions, ASME Member Discloses

American taxpayers were saved $65 million during the first six months of 1954, due to use of standards by the military services. This statement was made by R. V. Vittucci, Mem. ASME, standardization planning engineer of the U. S. Navy Department's Bureau of Ships, at the third annual meeting of the Standards Engineers Society. The meeting was held October 1 and 2 at Haddon Hall, Atlantic City, N. J.

By using standard parts in accordance with industrial practice wherever possible, Mr. Vittucci said, 45,000 unnecessary items were eliminated from the Supply System of the Defense Department from January through June, 1954. This resulted in a saving of 120,000 cu ft of storage space and 400,000 man-hours.

Mr. Vittucci called attention to new regulations issued in September that will increase Government economies by encouraging greater co-operation between Government and industry. These regulations make it possible for Government representatives to participate with industry representatives in developing standards used by both industry and Government, thus bringing industry and Government practices more nearly in line with each other.

International interchangeability is essential for improvement of world markets, Howard Coonley, Affiliate ASME, vice-president, Research Corporation, New York, N. Y., declared at the society's afternoon session on International Standardization and American Industry. "World peace cannot be attained on a sentimental basis or by hoping for it," he said. "World peace is only possible if you can find a means of interchanging goods and services on a basis profitable to all. The work of members of this organization is a big step toward that goal."

Confirming Mr. Coonley's emphasis on the importance of standards in world trade, Vice-Admiral G. F. Hussey, Jr., ASA managing director, declared that American industry should work to bring about greater acceptance of American Standards in other countries where standardization is not yet far advanced. This is necessary, he said, if U. S. goods are to hold their own in world markets. He cited a trend toward use of German standards in Latin America.

Money value is the key to management's acceptance of standards, H. Thomas Hallowell, Jr., president, Standard Pressed Steel Company, declared. He spoke on the place of standardization in management. From his own experience he showed how profits can be increased by eliminating the cost of making "specials." In times of depression or recession, standards-consciousness keeps men at work and provides economies that help break the effect of low production, he declared.

The Saturday morning session heard M. A. Williamson, manager, Research Division, Burroughs Corporation, describe the methods of setting up and operating a materials department. Skill in public relations is the most important tool for the head of the materials department, he said, since a materials department is called upon to provide information that in many cases is not readily available.

New Atomic-Energy Law AIF Conference Keynote

At a two-day conference sponsored by the Atomic Industrial Forum in New York, N. Y., September 27–28, more than 500 businessmen and industrial-research specialists studied the new atomic-energy law and discussed what it means to industry. Sessions on investment opportunities, forecasts by companies operating in the field, industry-government partnership, labor, and insurance were some of the topics which made up a full program.

Atomic-Energy Law

Included in the meeting were descriptions and interpretations of the recently-enacted atomic-energy law. Former AEC general counsel Everett Hollis, now of General Electric Company in New York pointed out that the new atomic-energy law affords private industry a larger role in the development of atomic energy and provides a framework for a greater degree of co-operation with other nations in the field of atomic energy (see pp. 995–998 of this issue).

Bennett Boskey of the law firm of Volpe, Boskey & Skallerup, spoke on the patent provisions of the Act. A basic change is that fissionable material, termed "special nuclear material" in the new Act, has been restored to the patent system. He said that this development along with other provisions of the Act makes it possible for private enterprise, pursuant to a licensing system administered by the AEC, to invest in and to own and operate facilities in the field of production of special nuclear material and of power.

Investment Problems and Opportunities

Armand G. Erpf of Carl M. Loeb, Rhoades & Company, in discussing investment problems, suggested the following curbs: When speaking of atomic energy and its possible future applications, scientists should strongly emphasize the uncertain time factor; in preparing annual reports industrialists should, without betraying secrets, give some idea as to the amount of money and number of men required in atomic-energy programs, together with the prospects for making an economic return; and that the AEC should decide how much can be told about the purely financial aspects of atomic energy.

What Industry Sees Ahead

A high light of the two-day meeting was a description of industry's outlook for the future in atomic energy under the new law by representatives of leading atomic facility and equipment manufacturers.

Eugene B. Hotchkiss, vice-president of the Vitro Corporation of America, said, "Our company recognizes that the new law brings industry a responsibility as well as an opportunity. We are doing our best to shoulder our part of that responsibility. We hope to share in equal measure in the opportunity."

Walter E. Kingston, general manager of the Atomic Energy Division of Sylvania Electric Products, Inc., said his firm was confident that low-cost power produced by means of atomic energy will become a reality within the next five to ten years because of progress now being made in the development of nuclear fuels and components of atomic reactors.

John W. Landis of The Babcock & Wilcox Company reported that his organization is devoting a significant portion of its facilities and resources to atomic-energy work. While the new Act has certain patent defects and administrative cumbersomeness, it is a long step in the right direction. He expressed the belief that within the next year his company would be prepared to quote firm prices on four types of reactors and he predicted that four or five companies will initiate power-reactor projects within the next two years.

John R. Menke of Nuclear Development Associates, Inc., discussing industry activity in the field of international atomic energy, declared that peacetime atomic power, as an instrument of foreign policy, has a good-will value almost without equal. Industrialized nations, with a little assistance from the United States, could build and operate their reactors; the less-developed countries will require that means be found to export not only technology but also the capital to pay for the new assets.

Concluding the discussion of the meaning of the new atomic law to industry, Arthur V. Peterson of American Machine & Foundry Company, stated that the law provides a basis for planning programs for analysis and consideration by company management.

Industry-Government Partnership

T. Keith Glennan, former atomic-energy commissioner, now president of Case Institute of Technology, described the new industry-government partnership in atomic energy. He said, . . . "What the Government does in the area of information dissemination will to a large extent indicate whether it regards its new associate—industry—as a true partner or something much less. . . In practice, I think the Commission must now permit people outside of its own program who are not security risks to have access to the classified information which they will need to educate themselves in atomic energy and to undertake projects which they—and not necessarily the Government—will consider to be worth while, and on which they—and not the Government—will risk the money. Furthermore, I believe the Government must permit these people, if they wish, to exchange classified information among themselves without going through Government channels and without first having to secure the approval of the Government."

Actions of the ASME Executive Committee

At a Meeting at Headquarters, October 20, 1954

A meeting of the Executive Committee of the Council was held in the rooms of the Society on Oct. 20, 1954. L. K. Sillcox, chairman, presided. In addition to Mr. Sillcox there were present: Thompson Chandler, A. C. Pasini, and W. F. Thompson of the Committee; Joseph Pope, chairman, Finance Committee; E. J. Kates, assistant treasurer; D. W. R. Morgan, president-elect; H. R. Kessler, vice-president; R. B. Lea, director; C. E. Davies, secretary; O. B. Schier, 2nd, assistant secretary; and T. A. Marshall, Jr., administrative assistant.

New Members

Four members of the American Institute of Electrical Engineers have been elected to membership in the ASME. Under the reciprocal arrangement with AIEE, the committee authorized reduction of dues payment by the new members.

1954 Dues-Exempt Members

As of Sept. 30, 1954, 73 members of the Society became dues-exempt, having paid dues for 35 years and having reached the age of 65 years. Also 118 who purchased life membership are now members of the "Old Guard." It was reported that a number of letters had been received from these members of the Old Guard expressing appreciation and thanks.

Registration-Fee Increase

The Committee approved an increase in the nonmember registration fee for the Spring, Semi-Annual, and Fall Meetings from $3 to $5, and for the Annual Meeting from $5 to $10.

1954 Machine-Tool Awards

The National Machine Tool Builder. Association withdrew its Machine Tool Design and Economic Value Awards after the ASME had solicited papers for these awards. Accordingly, the Committee voted to confer two awards, to be known as the 1954 ASME Machine Tool Awards on the following: First award to George N. Levesque, Mem. ASME, director of research, Brown and Sharpe Manufacturing Company, Providence, R. I., for his paper, "Testing Methods for Production of Accurate Machine Slideways"; and second award to Frank G. East, Mem. ASME, general manager, Hamilton Gear and Machine Company, Ltd., Toronto, Ont., Can., for his paper, "Proposal for a Standard Design for General Industrial Coarse-Pitch Cylindrical Worm Gearing."

Additional 1954 Awards

The following awards were approved:

Charles T. Main Award to John N. Pendergrass, Jr., Assoc. Mem. ASME, Southern Methodist University, Texas, for his paper, "The Engineer in Business and Industry."

Undergraduate Student Award (posthumously) to Raymond W. Lloyd, Jr., Newark College of Engineering, Belleville, N. J., for his paper, "Automatic Feeding to 1500-Ton Drawing Presses."

Mechanical-Engineering Film

Upon recommendation of the Seventy-Fifth

Anniversary Committee, the Executive Committee voted to approve the preparation of a motion picture to explain the role of mechanical engineering in the development of this country.

New Section

Section status for the Mid-Hudson Subsection of the Metropolitan Section was authorized.

Williston Award

Arthur L. Williston, a member of the Society for 58 years and an active leader, presented to the Executive Committee the deed of gift and securities for the "Arthur L. Williston Medal and Award." Under the terms of the deed of gift, the Society "shall grant at regular intervals, as far as practical, a Medal and Award to be known as the Arthur L. Williston Medal for 'Fostering Civic Service' which shall be given to successfully competing student or junior engineer in accord with the conditions set forth."

The Executive Committee voted to accept the deed of gift and to request the Board on Honors to set up the necessary procedure to administer the award.

Certificates of Award

Certificates of Award were granted to the following retiring chairmen of Sections: F. M. Staszesky, Boston; R. M. Meyer, Hartford; J. P. Heumann, Fairfield County; Norman Wilson, Worcester; Herbert Dobkin, Plainfield; Harry Knecht, Metropolitan; R. S. Sherwood, Northern New Jersey Subsection; J. M. Crone, Southern Tier; R. B. Mentzer, Susquehanna; C. C. Franck, Philadelphia; M. L. Baxter, Jr., Rochester; Edward Van Wagenen, Florida; A. C. Keiser, Jr., Birmingham; E. A. Rogers, Chattanooga; M. T. Delabar, Piedmont-Carolina; F. C. Kreitler, Jr., Erie; M. L. Smith, Columbus; D. D. Panabaker, Ontario; A. B. Heiberg, Akron; H. E. Frech, Jr., St. Louis; E. P. Hansen, Milwaukee; Harry Schonberg, Central Indiana; J. L. Wilkins, Nebraska; H. J. Stone, San Diego; M. W. Carbon, Columbia Basin; R. W. Beach, Western Washington; and R. W. Bice, New Mexico.

Certificates were also granted to the following retiring members of the 1954 Nominating Committee: R. S. Stover, chairman; A. C. Crownfield, Jr., S. B. Sexton, 3rd, S. T. Johnson, and C. A. Stevens. K. P. Hanson, 1953 secretary, also received a certificate.

Other certificates were awarded to T. W. Bostwick, chairman, Florida Section, 1952–1953; and to L. L. Amidon, retiring chairman of Region VI, Student Branch Committee.

ECPD Report

Annually ASME representatives on ECPD submit a formal report at the annual meeting of ECPD. The Executive Committee voted to approve the 1954 formal report of the ASME representatives for presentation at the ECPD annual meeting on Oct. 28–29, 1954, at Cincinnati, Ohio.

Report on Science Teachers

The Engineers Joint Council on Sept. 17, 1954, voted to recommend to its constituent bodies that they transmit to their local sections for action the Joint Report on High-School Teachers of Science of the Engineering Manpower Commission and the Scientific Manpower Commission. The EJC suggested that in the letter to the sections transmitting the report, emphasis be given to the following:

1 Engineers as professional people are vitally concerned about the quality and quantity of mathematics and science instruction that young people receive in their formative years;

2 Task outline in report can be handled only at the local level;

3 This is an excellent opportunity for the sections to make an important community contribution; and

4 The Engineering Manpower Commission of EJC is an excellent source of pertinent information not contained in the report.

The ASME Executive Committee voted to authorize the Secretary to mail to the sections the EMC-SMC Joint Committee Report on High-School Teachers of Science.

Benjamin Franklin Anniversary

At a previous meeting the Committee authorized participation in the 250th Anniversary Celebration of the birth of Benjamin Franklin. The Engineers Club of Philadelphia requested that a resolution be adopted by ASME for inclusion in the 1955 brochure on "Plan for the Celebration of the 250th Anniversary of the Birth of Benjamin Franklin." The resolution regarding the Society's participation in this celebration was approved.

Use of Society Emblem

The Society has received a request from the Dean of Engineering, University of Pittsburgh, Pittsburgh, Pa., asking permission to reproduce the emblem of the Society on a decorative terra-cotta strip to be used on the new engineering building at the University. This strip will include the seals of six engineering societies. Permission was granted for the use of the Society emblem for this purpose.

Appointments

The Committee voted to approve the appointments on Boards, Committees, and Joint Activities, made by the Organizations Committee at its meeting on Oct. 19, 1954. (Note: A list of these appointments may be found in ASME Annual AC-10, Personnel of Council, Boards, and Committees, to be issued in February, 1955.)

Presidential Appointments

The following presidential appointments were confirmed:

William F. Ryan to EJC-ECPD Committee on Practice of Engineering.

A. M. Lederer; alternates, S. E. Reimel, R. S. Aries, to Pan-American Federation of Engineering Societies (UPADI), São Paulo, Brazil, Aug. 2–6, 1954.

Ben G. Elliott, vice-president, to Fiftieth Anniversary Dinner of Engineers Society of Milwaukee, Oct. 19, 1954.

Engineering Societies Personnel Service, Inc.

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members, or nonmembers and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

Men Available[1]

Mechanical Engineer, 34, BSME, single; eight years' experience in varied background of product design, piping, and heating and ventilating; supervision of design and installation. Free to travel. Desires project engineering in North. Me-149.

Mechanical-Industrial Engineer, BSME, 29; time study, MTM, incentive installation, cost estimating, analysis, precision radar, ordnance, similar items in metalworking plant; presently senior cost estimator. Desires position with future. Me-150.

Mechanical Engineer, 37, currently project engineer with major materials-handling and pump-manufacturing company; desires position that can profit from 15 years of extensive administrative and engineering background. Me-151.

Mechanical Engineer, BSME, 25; married; over four years' diversified experience in product design, tool design, production planning and con-

[1] All men listed hold some form of ASME membership.

trol, and liaison engineering. Draft exempt. Will relocate. Me-152.

Executive Engineer, 53, registered; heavy experience in administration, consulting, product development, and industrial engineering. Ability to make decisions and get things done. Will relocate. Now in Pittsburgh area. Me-153.

Mechanical Engineer, BME, MSME; Tau Beta Pi; 28; single; three and three-fourths years' diversified experience, experimental and analytical stress analysis, some vibrations, thermodynamics, heat transfer. Desires foreign employment with opportunity. Me-154.

Mechanical Engineer, MSME; 20 years' diversified experience in machine, product and device design and development (patents). Broad knowledge of modern controls, commercial components, and manufacturing methods. Foreign languages. Held supervisory positions. Me-155-15-Chicago.

Assistant Chief Engineer, Patent and Development, 13 years' experience in machinery, metal-working, metal trades. Seeks small or medium-sized growing concern. Presently plant engineer; registered mechanical-industrial. Prefers suburban Pa. or rural New England. Me-156.

Mechanical Engineer, 39; MME, PE, 17 years' top experience product design, development, and manufacture machinery: electro-mechanical, servos, hydraulic; administration engineering department; plant engineering and operation. Desires position as management or design executive. Prefers New York, N. Y. Me-157.

Chief or Assistant Chief Engineer, 32, married; BSME, registered in Ohio; one and one-half years plant engineer; three and one-half years supervising, programming, and planning engineering work, plus design review, specifications, procedures, budgets, and tests. Prefers West Coast or mountain states. Me-159-1014-D-San Francisco.

Positions Available

Assistant to President, mechanical graduate, 40–45, machine-shop manufacturing experience as well as design and development of light machinery. Position requires tact in co-ordinating engineering as well as manufacturing and shop activities since successful applicant will almost immediately take over the president's responsibilities. $12,000 plus. Conn. W-269. Re-written.

Professor and Head of Mechanical-Engineering Department, graduate mechanical, doctor's degree, under 40, industrial and/or research experience, for newly organized mechanical-engineering department in an eastern college. Some consulting work possible. Salary open. East. W-514.

Chief Development Engineer, graduate, experienced in pulp and paper manufacturing and the application of pulp and paper-mill machinery and equipment to the manufacturing processes. This position requires the originating of ideas, procedures, and methods in the design and development of machinery. $7000–$8000. New England. W-528.

Engineers. (*a*) General sales manager, graduate engineer, for a medium-sized fabricator of pipe-expansion joints and steel fabricators of heat exchangers and other process equipment. Must have had some direct selling experience. Will co-ordinate operation of eight district offices and 40-odd sales agencies; co-ordinate advertising, sales-promotional literature, etc. About $15,000, with overriding bonuses based on new profits. (*b*) Engineer, graduate mechanical, or chemical. 28–40, for a medium-sized fabricator of pipe-expansion joints and steel fabricators of heat exchangers and other process equipment, to work up to chief engineer. Must be able to create thoughts and designs which have some sound basis and which can be manufactured economically. $10,000–$14,000, to start. Upstate New York. W-543.

Assistant Sales Manager and District Sales Manager, under 40, graduate engineers, sales experience covering hydraulic equipment, paper mill machinery, valves, hoists, presses, and heavy steel products. $8000–$12,000. Assistant Sales Manager, Ore.; District Manager, New York, N. Y. W-553.

Design Engineer, mechanical graduate, at least ten years' design and layout experience covering rotating machines. $7000–$10,000. N. J. W-561(*b*).

Works Manager, plant with 1200 employees fabricating heavy sheet metal and castings. Substantial company located in central region. $25,000. W-563.

General Manager, 35–50, for capital goods manufacturer. Manufacturing and engineering strengths are sought rather than sales. May now be employed in the engine, heat-exchanger, pump-compressor, or related industry. $30,000. Chicago area. W-564.

Executive Vice-President for a very large manufacturer of heavy mill, chemical, and other equipment of both special and standard design. Unusual opportunity. $50,000. Midwest. W-565.

Industrial Engineers, under 32, graduates, training in industrial engineering, at least four years' experience, and (*d*), (*e*), and (*f*) are limited to a total of two years. (*a*) Time standards; (*b*) manufacturing methods; (*c*) materials handling; (*d*) systems and procedures (manufacturing); (*e*) organization and planning; (*f*) statistical quality control. $5000–$7500. Traveling 40 to 50 per cent of time. Headquarters, East or Mid-west. W-570.

Administrative Engineer, 30–40, graduate, broad background in mechanical, chemical, and electrical-engineering practices, for work along the lines of testing, research, and development. $9000–$12,000. N. J. W-589(*a*).

Director, Engineering and Design, 42–50, ME degree; must have broad background in heavy-machine designing, plus an excellent understanding of machine-tools and shop problems. Will be responsible for the effective planning and direction of all engineering and design functions. $18,000–$20,000. Large eastern city. W-600.

Production-Planning Manager, 35–50, ME graduate; must be an expert in production planning. Background with a management-consulting firm would be acceptable, provided that in the candidate's career he has had line experience where leadership qualities have been evidenced. About $20,000. Midwest. W-603.

Standards Manager, 35–50, preferably a degree in industrial engineering or equivalent, six to eight years' experience including processing, methodizing, and establishing of standards in the field of press and screw machines, heavy and light machines, heat-treating, and metal finishing. Will be responsible for establishing proper standards by methods-time measurement or stop watch; responsible for gathering and analyzing manufacturing information, including methods, work-plan layouts, and materials; supervise analyzing of manufacturing operations by applying the principles of motion economy and work simplifications, etc. Salary open. Midwest. W-623.

Assistant or Associate Professor, not over 45, at least a BS degree in either mechanical or industrial engineering, to take charge of shop laboratories and all course work in this field. Should be thoroughly familiar with nearly all phases of metal processing and fabrication and be capable of getting ideas across to students. Salary and rank will depend on education and practical experience. Position starts Feb. 1, 1955. East. W-634.

Director of Engineering, 40–50, to take complete charge of a large engineering department in the electronic-device and aviation-instrument field. $20,000–$25,000. East. W-638.

Instructor or Assistant Professor, mechanical-engineering department. Should have an interest in the field of thermodynamics, heat power, and a flair for internal-combustion engines. Rank and salary will depend upon education and experience. Midwest. W-643.

Chief Methods Engineer, 35–45, preferably some job-shop experience. Must be thoroughly conversant with standards, operation-sheet writing, time study, and tooling for company manufacturing medium-sized machinery. $7500–$8000. Conn. W-658.

Industrial Management Engineer, degree preferred, minimum of ten years' experience covering production and management phases of industry. Some consulting experience is required. Must be willing to go to Europe for minimum assignment of two years. To $15,000. ⌂ W-661-D-9686.

Product Manager, mechanical-engineering graduate, experienced in design, administration, and industrial sales, to manage and direct the design engineering, sales, and service of a product in the power-transmission field. Will handle sales-promotional activities, matters of guarantee, pricing, and service of this product and particularly to supervise general engineering design and adaptations as required. About $10,000, plus incentive. Md. W-667.

Chief Engineer to take engineering charge of plant at executive level. Must have both administrative ability and engineering skill to operate department efficiently. Company manufactures processing equipment for dairy and food industries. Salary open. Pa. W-671.

Chief Engineer, 40–50, mechanical or electrical graduate, at least ten years' design and development experience covering electromechanical devices, synchros, slip-ring assemblies, etc. $15,000–$20,000. New England. W-674.

Project Engineer, 30–40, mechanical or chemical graduate, furnace-melting and process-industry experience, to take charge of design, development, and installation of metallurgical and manufacturing equipment. $6500–$8000. N. J. W-675.

Market Analyst, 35–45, mechanical-engineering graduate, to make market surveys. Must have sales, application, and market-survey experience. Considerable traveling. $8000–$10,000. Headquarters, New York, N. Y. W-682.

General Superintendent, under 50, to take over complete operating responsibilities of a modern, mechanized, high-volume, mass-production gray and malleable foundry. East. W-695.

Staff Engineer, 30–40, should have had several years' experience with a well-operated industrial-engineering department in the metals industry or a management firm. Some experience in heavy industry helpful. Should have experience in MTM, preferably with a certificate. Considerable traveling, but home usually on week-ends. $7000–$9000. Headquarters, New York, N. Y. W-696.

Machine Designer, from five to ten years' experience on small light machinery. Must assume responsibility for his own designs. $7000–$8000. Conn. W-697.

Development Engineer, graduate mechanical, from three to 20 years' experience in hydraulics and general developmental work in small mechanisms. Work in small-quantity production. Should have some creative ability. $6000–$9000. East. W-698.

Maintenance and Chief Engineer, engineering degree, 30–45, at least five years' experience in oil-refinery maintenance and construction and acquainted with Minnesota climate. Will take charge of all maintenance and engineering activity of new refinery including equipment for crude distillation, delayed coking, thermal catalytic cracking, hydrodesulphurization, and ultra-forming. $10,000–$12,000. Minn. C-2308.

Manufacturing Executive, mechanical graduate, 35–45, at least five years' experience in heavy machining, welding, and fabricating heavy-metal products. Knowledge of production and modern management. Will supervise 35 foremen, most of whom are ten to twenty-year employees, in manufacturing heavy equipment such as lift trucks, including welding, electrical assemblies, machining, and floor-assembly operations. Company manufactures materials-handling equipment. $9000–$15,000, depending upon experience. Employer will negotiate fee. Chicago, Ill. C-2315.

Mechanical Engineer, graduate, to supervise design and preparation of drawings for heating, ventilating, and air-conditioning work and air, water, and oil-piping systems specializing in hydro plants. Must have good appearance; be capable of presenting and discussing work and to supervise work of others. $7200–$10,800. For consulting firm on hydro plant work. Chicago, Ill. C-2330.

Design and Development Engineer, at least three years' experience required in design and development of industrial gas and oil boilers, 20 to 600-hp. Salary open depending upon experience and ability. Southwest Mich. C-2343.

Plant Manager, graduate mechanical or electrical engineer, to 45, at least five years' experience in radio and television industry. Will be in complete charge of all maintenance, production, and material control, quality control, inspection of large radio and television plant. No actual manufacturing; all assembly operations; plant employs 1000. $16,000. Chicago, Ill., suburb. C-2371.

Utilities Engineer, BS in electrical or mechanical engineering, or equivalent studies, 30–40, three to five years' experience with utility rates and rate analysis or other experience with a public utility providing knowledge of practices useful in exerting rate contracts. Studies light, power, heat, and water bills of large users, makes analyses, recommendations, and reports. Will work under registered engineer. $5200–$7020. San Francisco, Calif. S-249.

(*ASME News continued on page 1056*)

THIS PRODUCTION "DOUBLE CHECK" SAFEGUARDS YOUR BOILER INVESTMENT!

■ Yes, here is one extra production step we will never bypass! It is your guarantee of a *dependable*, long-life blow-off valve.

In this corner of the YARWAY Testing Department, *every Yarway Blow-Off Valve* is hydrostatically tested at 1½ times its rated maximum working pressure—proved drop-tight for service far beyond normal expectancy.

Not only blow-off valves, but *all* YARWAY equipment undergoes rigorous tests before leaving the YARWAY plant. Why? For one reason—to assure longer and better service in *your* plant. Over 15,000 boiler plants are using YARWAY Blow-Off Valves—some for twenty-thirty years, or longer.

Whenever you are in need of boiler blow-off valves, be sure to *make Yarway your way.*

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

steam plant equipment

BLOW-OFF VALVES
WATER COLUMNS AND GAGES
REMOTE LIQUID LEVEL INDICATORS
EXPANSION JOINTS
DIGESTER VALVES
STEAM TRAPS
STRAINERS
SPRAY NOZZLES

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Dec. 24, 1954, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

Key to Abbreviation

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member

New Applications

For Member, Associate Member, or Affiliate

BACKUS, WALTER E., Spokane, Wash.
BAKER, KEMPER W., St. Cloud, Seine, France
BARRETT, JACK R., Baltimore, Md.
BAUER, H. G., Pennington, N. J.
BEAVER, MARSHALL E., Worth, Ill.
BELLAK, SEYMOUR, Manchester, Conn.
BLUMFELDT, WALDEMAR G., JR., West Hartford Conn.
BOYER, ROBERT P., Glen Burnie, Md.
BRICKWEDDE, FERDINAND G., Washington, D. C.
BROWN, BYRON R., JR., Wilmington, Del.
BROWN, JAMES R., Butler, Pa.
BUSTAMANTE, SANTIAGO J., Los Alamos, N. Mex.
CAMERON, MORTIMER B., Wilmerding, Pa.
CANTWELL, GUY D., Dallas, Texas
CHASE, CARLTON E., Schenectady, N. Y.
CHERRY, HARVEY A., JR., Houston, Texas
CHRISTENSEN, JOHN G., Mount Vernon, N. Y.
CLARK, WILLIAM R., Chattanooga, Tenn.
CORTEN, HERBERT T., Urbana, Ill.
COUGHLIN, JOHN J., JR., Teaneck, N. J.
CRAMER, CARL A., Kensington, Md.
DAVIS, HARRY C., 3RD, Wilmington, Del.
DESHAZO, MYRON G., JR., Birmingham, Ala.
DODD, GERALD D., Martinsville, N. J.
DYSON, JAMES W., Honolulu, T. H.
EATON, EARL L., Kokomo, Ind.
ETEMAD, GHOLAM A., Buffalo, N. Y.
EUBANKS, ROBERT A., Flushing, N. Y.
FOLKERS, ROBERT A., Peoria, Ill.
FULTZ, CHARLES W., Omaha, Neb.
GARDINER, JOHN C., JR., Stamford, Conn.
GERTSON, DONALD K., Los Alamos, N. Mex.
GRAHAM, ROBERT L., Moline, Ill.
GRIESING, HAROLD C., Rockville, Conn.
GROSS, WILLIAM A., Ames, Iowa
GROSSKETTLER, JOHN J., Wallington, N. J.
HAMILL, CHALMERS, JR., Chicago, Ill.
HARDY, HORACE W., Catonsville, Md.
HASENBERG, EUGENE H., Morton Grove, Ill.
HAUBLER, LELAND M., Erie, Mich.
HEMPHILL, WADE O., Corning, N. Y.
HENDERSON, ROBERT A., Akron, Ohio
HENRY, JOHN M., Milton, Mass.
HIGBEE, LESTER C., Troy, N. Y.
HODSON, PETER, Wellsville, N. Y.
HOEY, GEORGE C., Greenville, Pa.
HOTZFIELD, WILLIAM A., Minneapolis, Minn.
HOWARD, JAMES T., Boonville, Mo.
HUFFAKER, PHILIP A., Signal Mountain, Tenn.
HULME, WILLIAM N., San Francisco, Calif.
JANVIER, PIERRE C., Woodstock, Md.
JAYCOX, CLINTON A., Detroit, Mich.
JETHANANDANI, HEMRAJ H., Ballarpur, M. P., India
JUDD, EDMOND H., Plantsville, Conn.
KNAPP, JOHN W., Orange, N. J.
KELLY, VINCENT P., Richland, Wash.
KORN, RICHARD F., Charlotte, N. C.
KRAUSE, HANS W., Summit, N. J.
LANDSMAN, HENRY, Scranton, Pa.
LEAF, LEROY R., Los Alamos, N. Mex.
LEE, HAROLD C., Richland, Wash.
LEISSA, ARTHUR W., Floral Park, L. I., N. Y.
LIGHT, JOHN L., Chattanooga, Tenn.
LIKENS, PERCY O., Erwin, Tenn.
LINTVEDT, HALVARD, Kalamazoo, Mich.
LOUGH, JACK S., Richmond, Va.
LYND, BURNHAM E., Moss Point, Miss.
MACCONKEY, LYSANDER H., Rock Island, Ill.
MARIEN, LOUIS P., Hyde Park, N. Y.
MCCLEARY, GAIL P., Chesterland, Ohio
MERRILL, KARL R., Salt Lake City, Utah
MOORE, CLINTON C., West Lynn, Mass.
MORRILL, WILLIAM K. P., Mobile, Ala.
MULHOLLAND, WILLIAM J., Trenton, Mich.
MURPHY, JAMES W., No. Syracuse, N. Y.
NELSON, GERALD N., Steilacoom, Wash.
NELSON, THOMAS, JR., Los Angeles, Calif.
NIXON, FORREST D., JR., Pensacola, Fla.
OBERG, ARCHIE Q., Glendale, Mo.
OTTMAN, ALLEN H., Ridgewood, N. J.
PARKER, CHARLES W., Marshall, Texas
PENIDO, DOMINGOS N., Harrison, N. J.
PLANTHOLT, ALBERT H., Baltimore, Md.
PRESTON, DELBERT H., Oak Park, Ill.
QUINN, JOHN J., Poughkeepsie, N. Y.
ROBERTS, ELBERT M., JR., Pensacola, Fla.
RUHLAND, EDWARD A., Union City, N. J.
SALTER, RICHARD G., Columbus, Ohio
SCHATTENBERG, JOHN W., San Antonio, Texas
SCHERR, HARVEY M., Anderson, S. C.
SEIDEL, ROBERT S., Elkhart, Ind.
SHELBY, A. JOHN, Rochester, N. Y.
SHIGLEY, JOSEPH E., Clemson, S. C.
SHROYER, FREDERICK E., Atlanta, Ga.
SHULMAN, MURRAY, Brooklyn, N. Y.
SHUR, VICTOR, Middletown, Ohio
SMILEY, LLOYD G., Hicksville, N. Y.
SMITH, CHARLES W., Baltimore, Md.
SOBALA, DANIEL, South Hadley, Mass.
SOCOLOFSKY, ARTHUR R., Chicago, Ill.
STEVENS, LAWTON T., Shreveport, La.
SWAIN, ALFRED G., Trenton, N. J.
TATTERSALL, WILLIAM L., Charleston, W. Va.
THOMPSON, ROY T., Houston, Texas
TROUP, COLIN, Sutton, Surrey, England
TRUNDLE, ROBERT C., Cleveland, Ohio
VINSON, ARTHUR F., New York, N. Y.
WADDELL, JOSEPH A., Holden, Mass.
WILLIAMSON, ROBERT B., JR., Aldan, Pa.
WILLS, ROBERT B., Baltimore, Md.
WITTERS, AMBROSE G., Batesville, Ind.
WOODWARD, DONALD W., S. Pasadena, Calif.
WU, WEN, New York, N. Y.
WULF, RICHARD F., Chillicothe, Ohio
YEARGAN, ROBERT D., Chattanooga, Tenn.
ZIERING, MARVIN B., Milwaukee, Wis.

Change in Grading

Transfers to Member or Affiliate

BROMFIELD, BURTON A., Weston, Mass.
BROWNLEE, JOHN A., Edmonton, Alta., Can.
BRUNNER, MATHIAS J., Broomall, Pa.
COX, JAMES E., Washington, D. C.
CRISSMAN, HARRY U., Dallas, Texas
DAVIS, HOWARD C., Columbus, Ohio
DOAR, FRANK G., Birmingham, Ala.
EDWARDS, AUSTIN S., JR., Ridgewood, N. J.
EDWARDS, LEO M., Hamden, Conn.
EDWARDS, THEODORE W., Fair Haven, N. J.
EVANS, JOHN G., JR., Toledo, Ohio
FULCHER, JOHN H., City View, Ottawa, Ont., Can.
FURCHGOTT, ARTHUR C., JR., Coral Gables, Fla.
GERARD, GEORGE, Yonkers, N. Y.
GRUNDITZ, DONALD W., La Crosse, Wis.
HEYWARD, THEODORE C., JR., Charlotte, N. C.
HOWARD, EDGAR S., St. Paul, Minn.
HURD, RICHARD C., Manchester, Conn.
IRVING, WILLIAM M., Natick, Mass.
KURTIS, ALAN A., New York, N. Y.
LOEWEN, ERWIN G., Cambridge, Mass.
MULTHAUP, ROBERT H., New York, N. Y.
NEWBY, WILLIAM M., Niagara Falls, Ont., Can.
NICHOLS, WALLACE H., Cleveland, Ohio
NORSE, FREDERICK B. W. Lafayette, Ind.
OLSON, DONALD R., Guilford, Conn.
PETERSON, HENNING L., Minneapolis, Minn.
PIERPOLINE, MARIO F., Wallingford, Pa.
POLK, ALBERT F., Dayton, Ohio
RAYLE, ROY E., JR., Springfield, Mass.
REETHOF, GERHARD, Cambridge, Mass.
SCHWERTFEGER, ANTON J., Aiken, S. C.
SHADE, WALTER R., Laureldale, Pa.
SMITH, HUELAND F., JR., Corpus Christi, Texas
SPRENGER, HERBERT D., Columbus, Ohio
STARRETT, RICHARD H., Elyria, Ohio
STEINHAGEN, WILLIAM K., Royal Oak, Mich.
TRUMMEL, JOHN M., Iowa City, Iowa
TUTTLE, JOHN A., Mount Vernon, Ohio
VIITANEN, VEIKKO K., Hoopeston, Ill.
WEBB, GEORGE H., Detroit, Mich.
WIGLE, ROY A., Yonkers, N. Y.
WILTS, RALPH C., New York, N. Y.

Transfers from Student Member to Associate Member 150

Obituaries . . .

Richard Terhune Anderson (1878–1954), vice-president and general manager, Paterson Parchment Paper Co., Bristol, Pa., died Aug. 9, 1954, at his home in Lawrenceville, N. J. Born, Passaic, N. J., Sept. 2, 1878. Parents, William S. and Sarah E. (Terhune) Anderson. Education, ME, Stevens Institute of Technology, 1902. Married Madeline Leonhard, 1916; children, David J., Margaret C. Assoc. Mem. ASME, 1919; Mem. ASME, 1920.

John Phillips Badenhausen (1876–1954), retired engineer of Philadelphia, Pa., died Aug. 21, 1954, at Bryn Mawr (Pa.) Hospital. Born, Hoboken, N. J., Jan. 31, 1876. Parents, Edmund C. V. and Katherine (Schoemer) Badenhausen. Education, ME, Stevens Institute of Technology, 1896; MME, Cornell University, 1900. Married Helen Mary Schneider, 1906 (deceased). Mem. ASME, 1922. Survived by three children, Bayard, Paoli, Pa.; Mrs. Helen B. Hendrix, Ardmore, Pa.; Mrs. Kathryn B. Newton, Philadelphia, Pa.

Edward Latrobe Bateman (1874–?), who died some time ago, according to a notice recently received by the Society, was managing director of Edward L. Bateman, (Pty.) Ltd., engineers and importers, Johannesburg, South Africa. Born, Evansville, Ind., June 21, 1874. Education public schools and night schools in Chicago, Ill. Jun. ASME, 1897; Assoc. ASME, 1904. He had been in South Africa since 1902 and did much to introduce and encourage American methods and machinery there.

Frederick Acton Boddy (1897–1954), a principal in the firm of Boddy, Benjamin & Woodhouse Associates, Detroit, Mich., died Sept. 2, 1954. Born, Petrolia, Ont., Can., Oct. 30, 1897 (of American parents). Parents, George A. and Mary (Acton) Boddy. Education, BS(ME), University of Michigan, 1924. Married Frances L. Trombley, 1916; daughter, Muriel (Mrs. F. A.) Dusel, Jr. Mem. ASME, 1944. He had been extremely active both in the affairs of the Detroit Section, of which he was past-chairman, and Region V, in which he had been a key figure in membership-development work.

Thomas Carr Bradford (1885–1954?), whose death was recently reported to the Society, was technical representative, F. E. Anderson Oil Co., Portland, Conn. Born, Providence, R. I., Dec. 22, 1885. Education, graduate, technical high school. Assoc. ASME, 1952.

Charles Worthington Comstock (1870–1953), retired engineer of Denver, Colo., died Sept. 18, 1953. Born, Maroa, Ill., Feb. 10, 1870. Education, EM and CE, Colorado School of Mines, 1890; MCE, Cornell University, 1894; PhD., 1898. Mem. ASME, 1908.

James Alfred Donnelly (1868–?), whose death was recently reported to the Society, was formerly president and general manager, Positive Differential System Co., New York, N. Y. His home was in Largent, W. Va. Born, Calverton, L. I., N. Y., Nov. 27, 1868. Education, graduate, public and high schools. Mem. ASME, 1911.

Eugene Lawrence Downs (1892–1954?), whose death was recently reported to the Society, was production assistant, Automatic Electric Co., Chicago, Ill. Born, Chicago, Ill., Nov. 14, 1892. Education, graduate, Calumet High School, 1910; studied accounting and factory management, Northwestern University's school of commerce, 1916. Assoc. ASME, 1944.

E. Root Dungan (1882–1954), mechanical engineer, Birds Eye-Snider Division, General Foods Corp., Rochester, N. Y., died at his home in Albion, N. Y., June 20, 1954. Born, Hiltonville, N. Y., May 25, 1882. Education, high school graduate; four-year steam-electrical engineering courses, ICS, 1912; civil engineering, 1916. Mem. ASME, 1941.

William Alsop Fannon (1863–1953), president, treasurer, The Fannon Trading Co., Inc., Appleton, Wis., died Jan. 15, 1953, according to a letter recently received by the Society. Born, Philadelphia, Pa., April 16, 1863. Parents, James and Ann (Downer) Fannon. Education, grade school in Philadelphia. Married Louisa E. Wannewetch, 1889; sons, George C., Ralph W. Mem. ASME, 1907. One of the founders of the Appleton (Wis.) Vocational School, 1916. Held patents on a hydraulic log-splitting machine and a pulpwood chip screen.

Henry Gebhart (1880–1954?), retired engineer, Dayton, Ohio, died recently according to a report received by the Society. Born, Dayton, Ohio, Dec. 17, 1880. Parents, Walter and Mary E. (Pope) Gebhart. Education, BS(EE), University of Pennsylvania, 1904. Married Harriet Helen Winters, 1917. He held several patents on streetcar equipment, including fare boxes, signal lights for car doors, and the like. Mem. ASME, 1919.

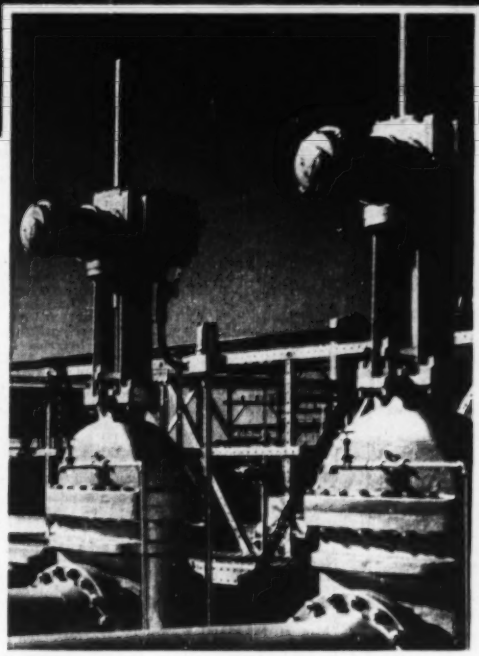
Russell Gray Henley (1884–1953), general superintendent of motive power, Norfolk and Western Railway Company, Roanoke, Va., died June 6, 1953, according to a notice recently received by the Society. Born, Walkerton, Va., May 17, 1884. Parents, Robert Y. and Dora (Walker) Henley. Education, graduate, Virginia Mechanics Institute, 1902. Married Anna W. Walden, 1915 (died 1936). Mem. ASME, 1947; Fellow ASME, 1947. In an article by Roy V.

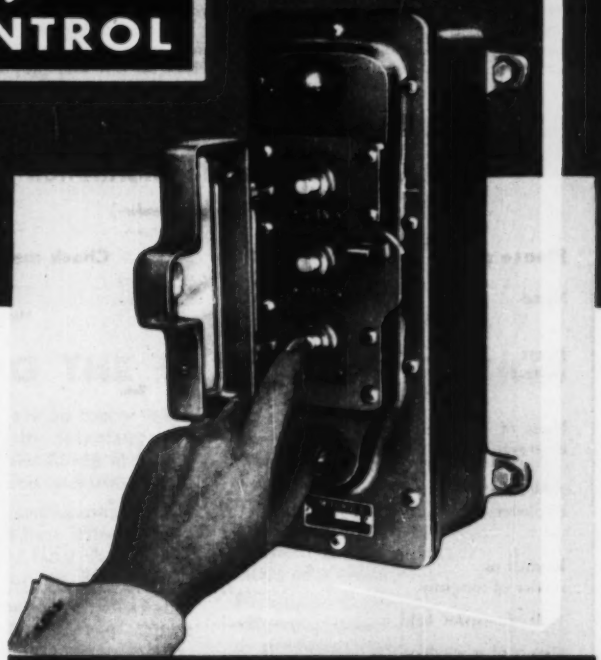
(ASME News continued on page 1058)

AUTOMATION?

...yes, at its Best with

Limitorque
REMOTE CONTROL





push button operation

More LimiTorques are in daily use throughout the World, than all other makes combined. LimiTorque is now adaptable to Microwave Control, if desired. Write for Catalog L-54.

See us at Booth 539 International Exhibit of Power & Mechanical Engineering — Convention Hall, Philadelphia: Dec. 2 to 7 incl.

Throughout Industry today, there is an ever increasing demand for Automatic Control and Operation . . . to save time, labor and money . . . to assure safety and absolute dependability.
AUTOMATION is not new in valve operation, because, for over 25 years thousands of important valves have been operated by LimiTorque push-button control in Refineries, Oil and Gas Pipe Lines, Central Stations, Power Plants, Paper and Pulp Mills, Water and Sewage Plants, Chemical Plants, and on Shipboard. . . . And, LimiTorque not only opens and closes valves, but it automatically shuts-off the current, should an obstruction be encountered in closing. . . . Another feature, should there be a failure in the power lines, LimiTorque can be readily de-clutched and manually operated by the handwheel.

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.

Industrial Gears & Speed Reducers

LimiTorque Valve Controls

Wright in the June, 1943, issue of *Railway Mechanical Engineer*, he had this to say of Mr. Henley: "The mechanical department, an important factor in the operations of any railroad, had given an unusually good account of itself on the Norfolk & Western, and the fact is recognized generally in railroad mechanical circles, Russell Gray Henley has headed it up since 1928; he is also vice-chairman of the Mechanical Division, AAR." Survived by son, Russell G., Jr., Roanoke, Va.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions' enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting this information is printed on this page. Please use it to keep the master file up to date.

ASME Master-File Information

(Not for use of student members)

Please print **Check mailing address**

Name ..... (Last) (First) (Middle)

Home address ..... ☐ (Street) (City) (Zone) (State)

Name of employer .....

Address of employer ..... ☐ (Street) (City) (Zone) (State)

Product or service of company .....

Title of position held .....

Nature of work done .....

I am a subscriber to (please check)

Publication	*Address changes effective when received prior to:*
☐ Mechanical Engineering	10th of preceding month
☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

Please register me in three Professional Divisions as checked:

☐ A—Aviation	☐ J—Metals Engineering	☐ S—Power
☐ B—Applied Mechanics	☐ K—Heat Transfer	☐ T—Textile
☐ C—Management	☐ L—Process Industries	☐ V—Gas Turbine Power
☐ D—Materials Handling	☐ M—Production Engineering	☐ W—Wood Industries
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ Y—Rubber and Plastics
☐ F—Fuels	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ G—Safety	☐ R—Railroad	
☐ H—Hydraulics		

Fred P. Hutchison (1894–1953), retired engineer, Orange, N. J., died July 21, 1953. Born, Maryville, Mo., Sept. 13, 1894. Parents, Samuel O. and Anna B. (Mosteller) Hutchison. Education, BS(Eng), University of Missouri, 1916. Author of several technical papers published in professional journals. Jun. ASME, 1918.

Leon Henry Johnson (1884–1954), chief engineer, Struthers-Wells Corp., Warren, Pa., died June 8, 1954. Born, Jamestown, N. Y., Dec. 31, 1884. Parents, Henry and Ada S. Johnson. Education, BS(Naval Arch.), University of Michigan, 1908. Married Ruby R. Rundquist, 1914; children, Sheridan R., Gretchen C., Martin H. Mem. ASME, 1939.

Thomas Doying Jones (1924–1954), research engineer, Wood River Research Laboratories, Shell Oil Co., Inc., Wood River, Ill., was killed in an automobile accident, Aug. 27, 1954. Born, Jacksonville, Ill., Aug. 26, 1924. Education, BSME, Missouri School of Mines, 1947. Jun. ASME, 1948.

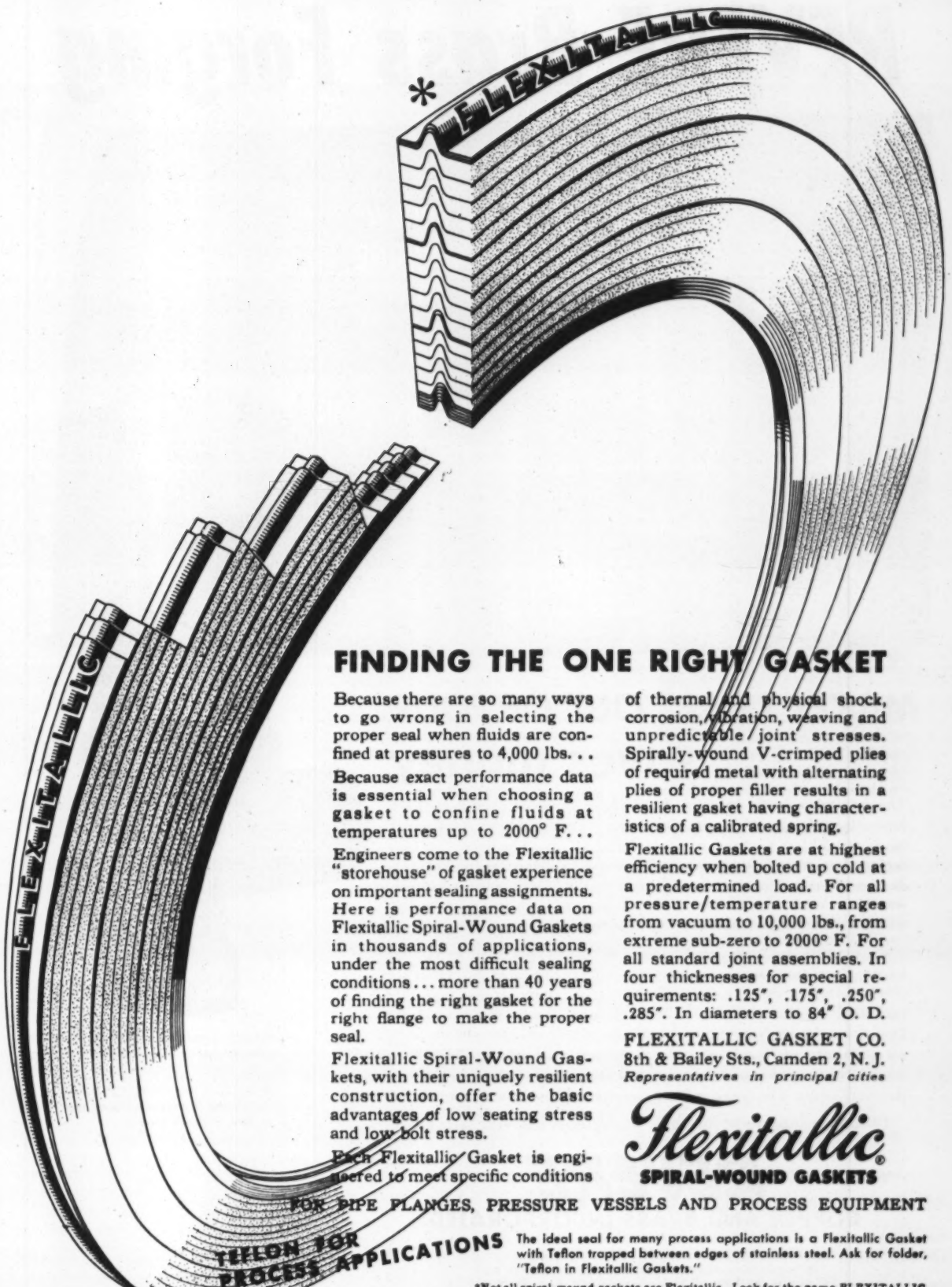
William Frederic Kiesel, Jr. (1866–1954?), whose death was recently reported to the Society, was formerly mechanical engineer in charge of mechanical-engineering office, Pennsylvania Railroad, Altoona, Pa. Born, Scranton, Pa., Sept. 1, 1866. Parents, Wilhelm F. and Marie Johanna (Neufer) Kiesel. Education, ME, Lehigh University, 1887; hon. DE, 1931. Married Alice Sweigard, 1888; children, Mildred V., John S., William F., 3rd. In 1928 he received the George R. Henderson Medal awarded by The Franklin Institute. Mem. ASME, 1907. In 1951 the Altoona Engineering Society presented him with a certificate of appreciation. He was awarded a gold medal in 1915 by the Panama Pacific International Exposition. He held 135 Pennsylvania Railroad engine and car patents.

Robert Jacob Trinkle (1893–1954?), whose death was reported to the Society, was professor of mechanical engineering, Virginia Military Institute, Lexington, Va. Born, Dublin, Va., Oct. 15, 1893. Parents, Jacob S. and Kathrine (Lyons) Trinkle. Education, BS(EE), Virginia Military Institute, 1914; MS(EE), Massachusetts Institute of Technology, 1926. Married Eleanor Lore Crane, 1923; children, Robert J., Anne W., Nelson C. Assoc.Mem. ASME, 1930; Mem. ASME, 1935.

William Buckout Tuttle (1874–1954), chairman, San Antonio River Authority; consulting engineer, City Public Service Board, San Antonio, Texas, died Sept. 8, 1954. Born, Austinburg, Ohio, July 3, 1874. Parents, Albert H. and Kate (Seeley) Tuttle. Education, University of Virginia, Class of 1896. Married Leila House, 1897. Mem. ASME, 1905; Fellow ASME, 1945. One of the prime projects of his career—San Antonio flood control—which he had worked on for the past 25 years, was brought to successful conclusion during the week before his death, when President Eisenhower signed the bill recently passed by Congress. He took an active part in local and national civic projects. Survived by wife; and two nieces, Mrs. James W. Hampton, Charleston, W. Va.; Mrs. Pembrock Gochnauer, Berkeley, Calif.

Jacob Latch Warner (1876–1954?), whose death was recently reported to the Society, was special assistant, service department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Born, Haverford, Pa., Jan. 11, 1876. Parents, Gardiner L. and Jane (McConnell) Warner. Education, BS, University of Pennsylvania, 1899; CE, 1902. Married Helen Wells, 1911; daughter, Barbara R. (Mrs. H. P.) Hartley. Mem. ASME, 1917. Author of several technical papers and contributed to textbooks used in the field of chemical engineering.

Henry George Yates (1908–1954), senior designer, The Parsons and Marine Engineering Turbine Research and Development Association, Pametrada Research Station, Wallsend-on-Tyne, Northumberland, England, died Sept. 15, 1954. Born, Nenagh, Tipperary, Ireland, May 5, 1908. Education, graduate, Methodist College, Belfast, 1926; BA, Trinity College, Dublin, 1930; MA, 1933. He held 14 British Patents; jointly with others, eight. He was a member and took active part in the affairs of leading British professional societies. Author of various confidential and unpublished reports; several articles published in *The Engineer;* his paper, "Vibration Diagnosis in Marine Geared Turbines," published by N. E. Coast Institution of Engineers and Shipbuilders, won for him the Engineering Gold Medal. Mem. ASME, 1952.



FINDING THE ONE RIGHT GASKET

Because there are so many ways to go wrong in selecting the proper seal when fluids are confined at pressures to 4,000 lbs. . .

Because exact performance data is essential when choosing a gasket to confine fluids at temperatures up to 2000° F. . .

Engineers come to the Flexitallic "storehouse" of gasket experience on important sealing assignments. Here is performance data on Flexitallic Spiral-Wound Gaskets in thousands of applications, under the most difficult sealing conditions . . . more than 40 years of finding the right gasket for the right flange to make the proper seal.

Flexitallic Spiral-Wound Gaskets, with their uniquely resilient construction, offer the basic advantages of low seating stress and low bolt stress.

Each Flexitallic Gasket is engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally-wound V-crimped plies of required metal with alternating plies of proper filler results in a resilient gasket having characteristics of a calibrated spring.

Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000° F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". In diameters to 84" O. D.

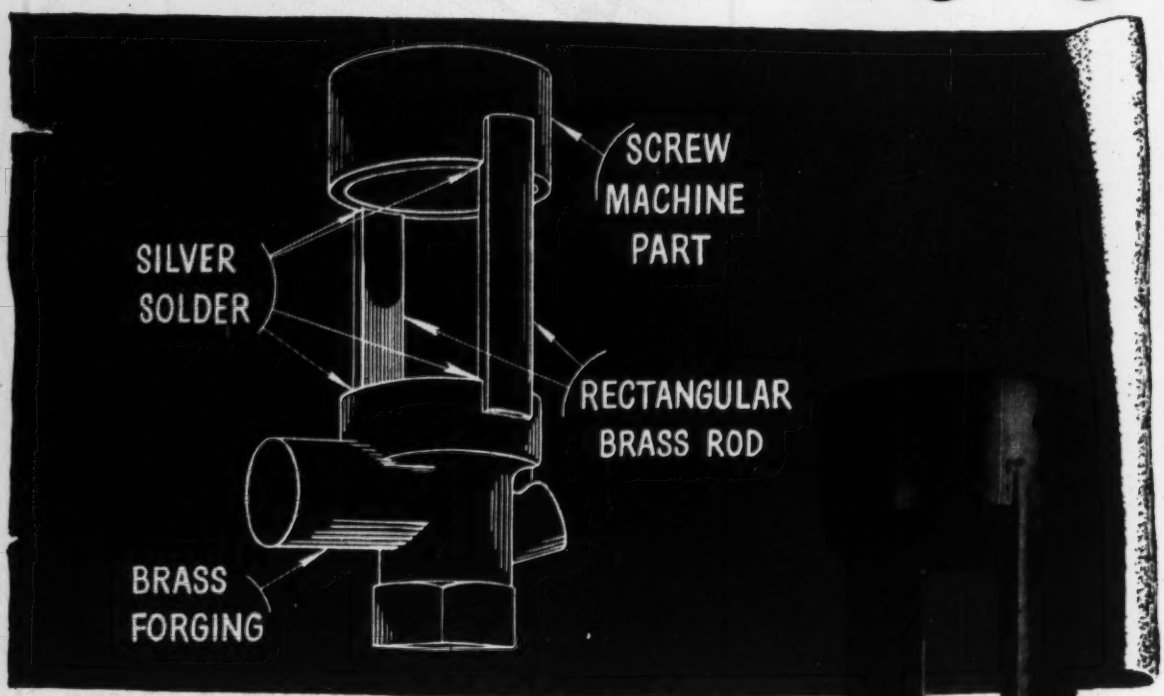
FLEXITALLIC GASKET CO.
8th & Bailey Sts., Camden 2, N. J.
Representatives in principal cities

Flexitallic®
SPIRAL-WOUND GASKETS
FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

TEFLON FOR PROCESS APPLICATIONS The ideal seal for many process applications is a Flexitallic Gasket with Teflon trapped between edges of stainless steel. Ask for folder, "Teflon in Flexitallic Gaskets."

*Not all spiral-wound gaskets are Flexitallic. Look for the name FLEXITALLIC stamped into the metal spiral of every genuine Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler.

REVERE Brass Forging



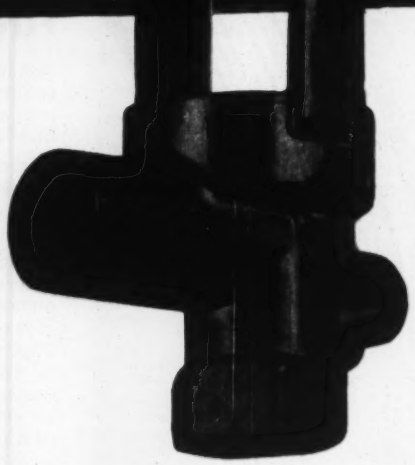
MAKES 1 PART OUT OF FOUR

. . . saves money

The one-piece brass forging shown here replaces a built-up part, formerly made of a screw-machine part, a forging, and two rectangular bars, assembled by four silver-soldered joints. The latter in turn replaced an iron casting, which was more expensive than expected, due to rejects. The part goes into a visible force-feed lubricator, which can operate at several thousand psi., and can be controlled to feed just a drop at just the right time to such equipment as compressors.

We suggest you look into forgings of copper, brass, other copper alloys, aluminum alloys. The forging process produces parts that are dense, non-porous, have many design details accurately and smoothly executed, require a minimum of machining. Revere knows a great deal about the forging of non-ferrous metals. In the case shown here, we collaborated closely with the customer in designing the part so it could be forged in one piece instead of being assembled out of four different items. The result is a better part, and appreciable economies.

For information about forgings, see the nearest Revere Sales Office.



Partially-machined brass forging for sight feed of force-feed lubricator.

At top, drawing showing how this part formerly was assembled out of four different pieces.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N.Y.

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere.

SEE "MEET THE PRESS" ON NBC TELEVISION, SUNDAYS

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Available literature or information may be secured by writing direct to the manufacturer. Please mention MECHANICAL ENGINEERING

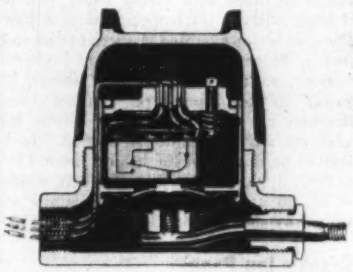
NEW EQUIPMENT

Orfice Flow Sections

Daniel Orfice Fitting Co., 3352 Union Pacific Ave., Los Angeles 23, Calif., announces orfice flow sections for small flow measurement of liquids and gases.

The units are designed for use with any make of differential recorder or indicator. Light weight flanges have dowel pins for perfectly aligning flanges and concentrically locating gaskets and orfice plate, company engineers point out.

Pressure tap holes can be adjacent to either each other or individually rotated on either vertical or horizontal axis to suit conditions. According to company engineers, tubes are honed to extremely close tolerances to assure uniform line size and internal finish.

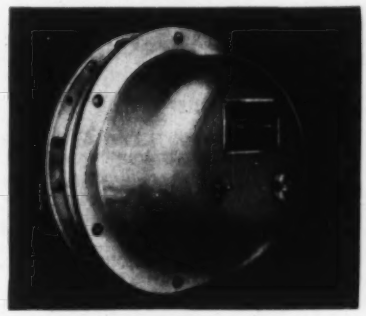


Explosion Proof Switches

Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif., announces new explosion proof pressure and vacuum switches said to repeat with ±1 per cent of setting.

The switches are enclosed in an explosion proof housing, UL approved for hazardous locations; Class I, group B, C and D; Class II, group E, F and G., for atmospheres containing vapors of ethyl, ether, gasoline, alcohol, acetone, petroleum, naphtha, lacquer solvents natural gas, grain dust.

The new line covers the range from 30 in. of mercury vacuum to 150 psi, sensing increasing or decreasing vacuum pressure, the company says. Standard models are available for single or dual settings. Bulletins describing the switches are available from the company.



Bin Level Indicator

A new model bin level indicator incorporating a built-in bull's-eye signal light for use in installations requiring a signal which can be readily seen by an operator, is announced by the Bin-Dicator Co., 13946-96 Kercheval, Detroit 15, Mich.

The new model has been designated Model "AL" Special Bin-Dicator and is said to be a complete, visual signal system in one package. It comes completely assembled and ready for connection to the user's power source. A toggle switch is provided so that the signal light may be shut off if desired.

The unit, which costs $12.50 more than a standard model without light is particularly suitable for use on packaging hoppers, scale hoppers and small bins handling practically any bulk material, the company says.

The unit is available with general purpose Micro switch only. It contains no springs and no motors, and the switch mechanism is operated by a flexible diaphragm which is actuated by pressure of the material in the bin or hopper. Various diaphragm materials are available including cloth, rubber, neoprene with cloth interlining, Fiberglas, asbestos cloth of several thicknesses.

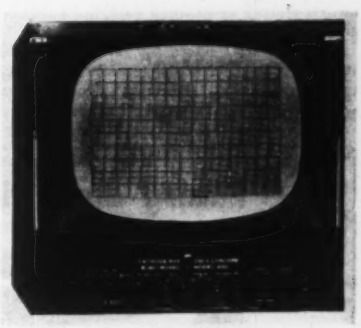
Service Compressor

A new compressor, Model HT-325, designed for mounting in service trucks, has been announced by Quincy Compressor Co., Quincy, Ill. A tank outlet manifold supplies reduced air pressure for tools and full pressure for other requirements, the company says. Tank pressure from 165 to 175 psi is automatically maintained by a constant speed unloader. Maximum continuous pressure is 175 psi. According to the company the gasoline engine can be started with a pull rope of an electric starter powered by the truck battery. The compressor is compactly designed to permit mounting on the smallest pick-up truck.

New Die Steel

Allegheny Ludlum Steel Corp., has announced production of a new die steel, known as Ottawa 60, specifically developed to deep draw and form stainless steel. It is a high carbon-high vanadium alloy, produced in bars and forgings, to perform in such applications without galling or pickup and to give the ultimate in wear resistance.

Detailed information on the material is available in a technical data sheet obtainable on request from the company, 2020 Oliver Bldg., Pittsburgh 22, Pa.



Large Screen Oscilloscopes

Large screen precision oscilloscopes are a new product development announced by Electromec, Inc., 3200 N. San Fernando Blvd., Burbank, Calif. They are available in 21 and 17 in. rectangular tubes, and are designed for data plotting, production test, wave form analysis, education and display uses.

Company engineers say important features of the new oscilloscopes include high resolution, ±1 per cent linearity, stable d-c amplifiers, calibrated time base (from 10 u sec./in. to 1 sec./in.), gain controls calibrated in peak to peak volts/in., (10 mv peak to peak or 1 mv peak to peak sensitivity), low rate of drift and excellent long term stability. Performance is not affected by line voltage changes from 105–125 v, the company says.

The manufacturer states that the new large screen oscilloscopes permit detail observation of large quantities of data or complex wave forms, thus reducing guess work and reading errors to a minimum. Use of magnetic deflection systems make large screen display practical, and permits close control over linearity and orthogonality, the company claims.

Instantaneous Battery Testing

A battery test switch for the instantaneous testing of both transmitter and receiver batteries is now being engineered into the company's latest model "505" pipe detectors, the Detectron Corp., North Hollywood, Calif., announces.

This new feature enables the operator to have positive assurance of maximum battery function at all times while detecting, tracing and estimating the depth of buried pipes, cables, conduit, the company says.

Engineers point out that battery testing on pipe detection equipment now in use has been a more complicated process with the result that in-the-field malfunction of equipment and battery failure has often occurred. Now, the company says, by merely touching the test-switch, an immediate reading of battery condition is possible. Batteries in poor condition may be replaced on the spot or extra replacement batteries taken into the field. Present owners of older model "505" pipe detectors can readily install the test-switch feature at nominal cost, according to the company.

The new unit offers the latest electronic tubes, a specially constructed vibration pick-up for maximum sensitivity, an aluminum case and the use of standard batteries. Constructed for rugged field use, it can be operated by one man. Experience or special training is not necessary.

Functions performed by the new model are the detection of unknown pipes and conduits, and cables, valves, services and stubs. It will also trace buried pipes and conduits and will center them to determine the exact location. The company says detection of unexpected or unknown metal objects is also possible and where there are close parallel pipes and conduit, the unit will determine the exact center, depth and location of any one of many pipes.

Proportional Counter

A proportional counter, WL-6307 for the detection of thermal neutrons is available from the Westinghouse Electric Corp. Box 284, Elmira, N. Y. The counter is filled to a pressure of 55 cm Hg with boron trifluoride enriched to 96 per cent with boron-10 isotope. The sensitivity of the counter is approximately 4.5 counts per second for a unit thermal neutron flux and it operates in the vicinity of 2000 v, according to the company.

The unit is extremely rugged and will operate at temperatures up to 80 C, the company says. It has an all-aluminum body one in. in diam and 12-in. long. It is provided with a connector for HN cable fittings.

Making Warm Friendships on Hot Jobs

WATER JACKETED APCO PUMP
Developed especially for the efficient handling of high temperature and highly volatile liquids. Delivers outstanding performance. Unbeatable on high head, small capacity duties.

PUMPS by Aurora

For Every Purpose

APCO Turbine-Type PUMPS
—ideal for "1001" duties where small capacities and high heads predominate. Get acquainted.

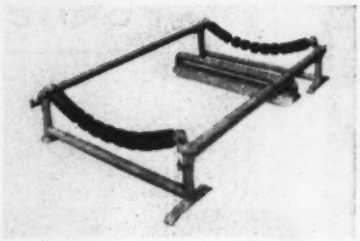
AURORA CENTRIFUGAL PUMPS
are available in many types and sizes—all noted for their streamline coordination between impellers and shells.

Write for CONDENSED CATALOG "M"

We Invite Your Special Pump Problems

DISTRIBUTORS IN PRINCIPAL CITIES

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY
86 LOUCKS STREET AURORA • ILLINOIS



Belt Conveyor Idler

A cable-suspension idler for belt conveyors, announced by Joy Mfg. Co., Pittsburgh 22, Pa., is said to provide a load-conforming catenary, cushion the belt, and handle both bulk and packaged materials.

Known as the Limberoller, it uses only two bearings, and carries the belt on resilient, pressure-molded neoprene disks, all of the same size and all revolving at the same peripheral speed. Discs are molded to a neoprene-sheathed, flexible steel cable, freely suspended from the two bearings. In continuous contact with the loaded belt, the discs exert a slight gripping action that holds slippage to a minimum, and tends to keep the belt aligned. The company says the discs have excellent resistance to abrasion, will not support combustion, and will resist most chemicals except very strong oxidizing agents and aromatic hydrocarbons.

Bearings are supported above and to each side of the belt, out of the dirt zone; are locked in place with spring clips; can be changed without interrupting material flow. The unit is slot-mounted in special bracketed stands, which are assembled into conveyor sections, without bolts or cover sheets, by means of bed-frame-type channel rails. Brackets are also available for bolting the idler to any conventional section. It is said to permit conveyor heights from 13¼ to 15¾ in., and is available for belt widths of 24, 30 and 36 in. Further details are offered by the company in Bulletin LD-103.

Graphic Ion Panel

Graver Water Conditioning Co., 216 W. 14th St., New York 11, N. Y., now has available a graphic panel arrangement for all automatic ion exchange equipment that is said to allow the operator to see at a glance if the system is functioning properly.

On the panel control board is located, in addition to the usual controls, meters and recorders, a pictorial representation of the ion exchange units and the immediate piping and valves. Each valve representation has two colored lights, one red, one green. When the operation valve is open, the green light is on, when the valve is closed the red light is on. All pipe lines are also lit and colored with a different color for each material being carried.

This system, designed for large utility demineralization plants, mixed-bed and two-bed demineralizers and hydrogen-sodium blend systems, can be modified to meet individual plant needs.

Air Tool Lubricators

A new line of Micro-Fog lubricators for air tools, air cylinders, and other air-operated equipment has been announced by the C. A. Norgren Co., Englewood, Colo. The company says the outstanding feature of the new lubricators is an easily adjusted variable vane venturi which enables one unit to meet the requirements of a much wider range of operating conditions, and handle applications which previously required several sizes of lubricators.

The company says that at 80 psi the $^3/_8$ in. size can be set for a low flow range of 5 to 9 cfm, a high range of 50 to 100 cfm, or any intermediate range desired. The new line includes 20 models in pipe sizes of $^1/_4$, $^3/_8$, $^1/_2$, $^3/_4$, and 1 in., with capacities of $^1/_2$ pt, $1^3/_4$ gal and $4^1/_2$ gal, and flow range from 5 to 250 cfm at 80 psi.

The new units have a transparent dome for visibility of oil feed; visibility of oil supply; an auxiliary air circuit for accurately controlling the oil feed from 1 drop in 20 minutes to 15 drops per minute. A constant oil level feature, available in all types, eliminates the possibility of the rate of oil feed being affected by the quantity of oil in the bowl.

Micronic Filter

Waterman Engineering Co. of Evanston, Ill., has perfected a new high pressure micronic filter said to feature easy replacement of elements without breaking pressure line connections. According to company engineers, full flow filtration of high pressure air, oil, water or any mild corrosive fluid can now be accomplished with this micronic filter.

The company says that complete protection from contamination is assured valve, cylinders and fluid motors. Also a built-in relief valve prevents crushing of filter element due to dirt accumulation.

Two types of elements are available—one filters to 40 microns, the other to 10 microns. An illustrative circular of this new micronic filter may be obtained by writing the company, 725 Custer Ave., Evanston, Ill.

Induction Heater

A new 25-kw high frequency vacuum tube induction heater, Type EI-25C, engineered for heavy duty industrial use, has been announced by Allis-Chalmers Mfg. Co.

The entire cubicle of the new unit is pressurized. Ambient air is drawn into the heater near the top, filtered, blown downward through the oscillator, through a baffle, into the rectifier section, and then exhausted through a grille on the rear panel of the cubicle. Ceramic coils are used to carry cooling water to high potential parts.

The heater's newly designed cabinet is formed from heavy gage steel, rigidly constructed, and fitted with full-length doors for "walk-in" accessibility to the rectifier and oscillator sections.

According to the company, performance of the new heater has been improved, tube life lengthened, and maintenance further reduced by the use of regulated voltage on the filaments of all tubes and the application of a single oscillator tube of latest design.

Safety features incorporated in the heater include heavy duty industrial control, high-water temperature switch, low water flow switch, fuses, and interlocking doors which automatically shut off the power when opened.

The completely self-contained electronic heater features automatic timing for each unit operation. The operator merely pushes the start button which closes the circuit for the predetermined time for the operation as established by proper setting of the timer. Operations can be either manual or automatic depending upon the production setup for the job.

A description of the new heater, including dimensions, is given in a new bulletin, 15 S 8057, copies of which are available on request from Allis-Chalmers Mfg. Co., 949 S. 70th St., Milwaukee, Wis.

Aluminum Conductor Alloy

A new aluminum alloy for conducting electricity, No. 2EC, has been developed by Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa. The company says the alloy is a tailor-made material developed to meet the high performance requirements of the electrical equipment manufacturing industry.

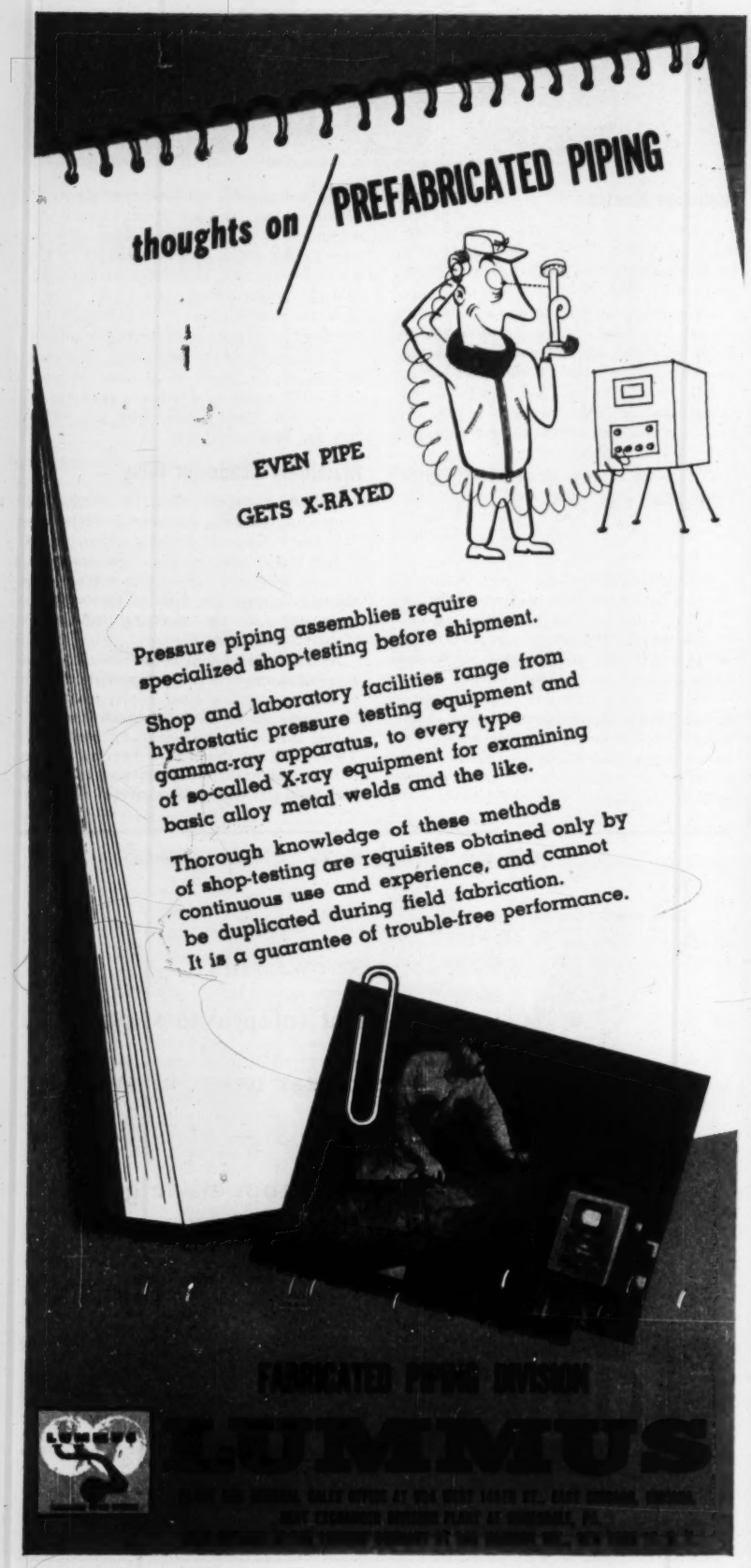
No. 2EC aluminum conductor alloy has superior mechanical properties, with a slight sacrifice in electrical conductivity over other aluminum alloys used for conductor purposes, according to company engineers. They point out that such properties are especially important for applications requiring high yield strength and low creep.

Everyone knows this
is the sign of telephone service . . .
And smart gear users know
this CINTI is the sign of
the best in custom made gears.

May We Send You Our Brochure?

CINTI "Gears . . . Good Gears Only"

THE CINCINNATI GEAR CO. • CINCINNATI 27, OHIO


thoughts on PREFABRICATED PIPING
EVEN PIPE
GETS X-RAYED
Pressure piping assemblies require specialized shop-testing before shipment.
Shop and laboratory facilities range from hydrostatic pressure testing equipment and gamma-ray apparatus, to every type of so-called X-ray equipment for examining basic alloy metal welds and the like.
Thorough knowledge of these methods of shop-testing are requisites obtained only by continuous use and experience, and cannot be duplicated during field fabrication. It is a guarantee of trouble-free performance.

KEEP INFORMED

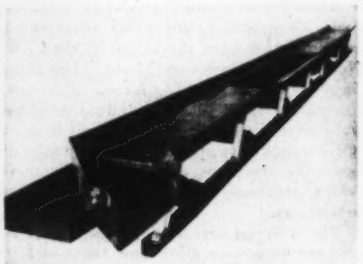
NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Stainless Steel Valves

A new line of lower-priced stainless steel Rockwell-Nordstrom lubricated plug valves especially recommended for use in food, plastic, sulfite pulp and chemical plants has been introduced by the Meter and Valve Div. of Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.

Featuring chrome-plated plugs, the new valves are said to be suitable for most services in which the more expensive stellite-coated Rockwell-Nordstrom stainless steel valves have previously been used, such as services requiring stainless steel to prevent contamination or corrosion.

According to company engineers, the chrome plating backed by stainless steel offers double protection against scoring, galling and other effects of corrosion. New valves are offered in the same sizes and types available in Rockwell's higher-priced line.



Vibrating Conveyors

Carrier Conveyor Corp., Louisville, Ky., announces bulletin No. 111 describing its processes and equipment, including the application of its natural frequency principle now being offered in new conveyors, shake outs and feeders.

This principle is designed to take all possible strain off the drives, motors and structural parts in vibrating conveyors, yet still allow the springs to operate freely and naturally. Engineers explain the vibration as that of a coil spring with a weight tied to it vibrating without any power input.

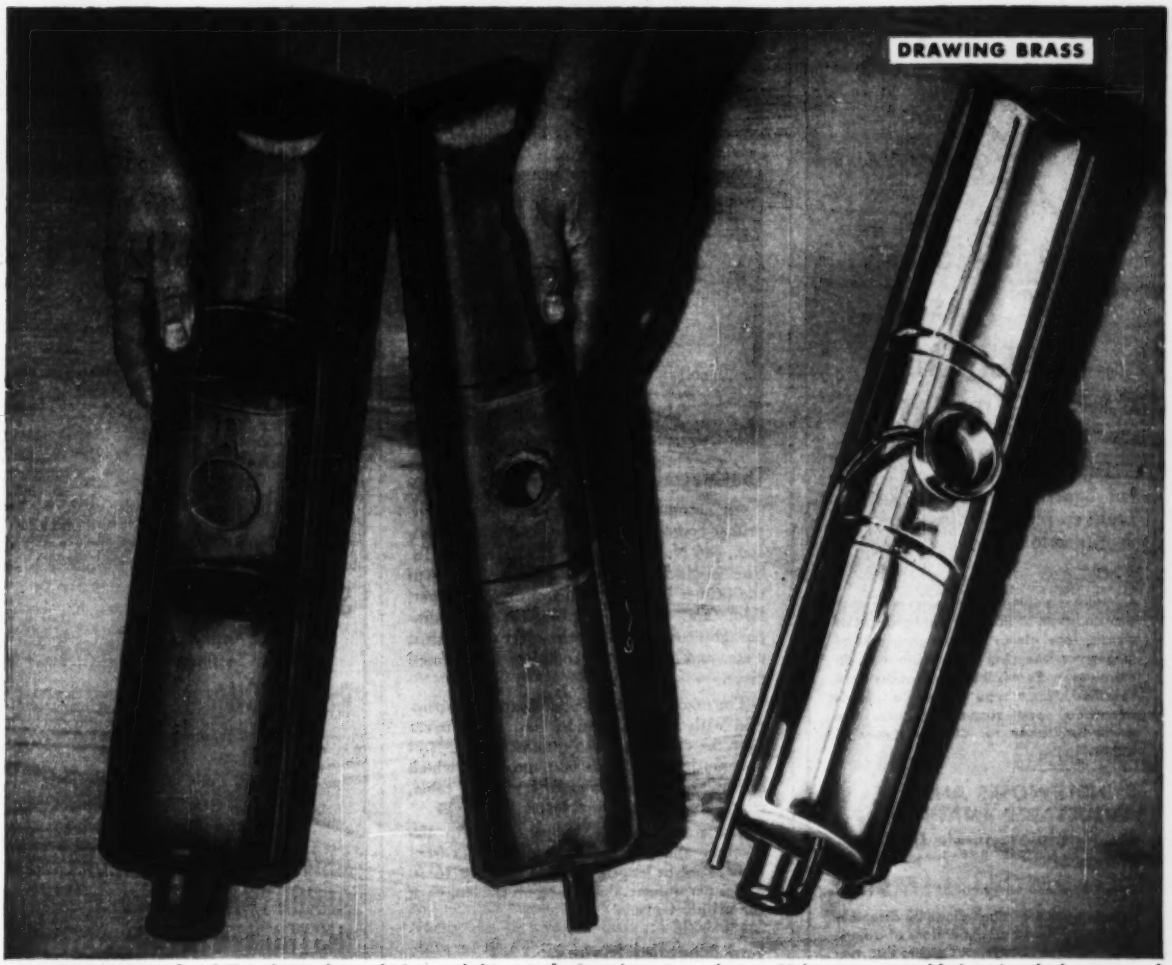
The company says the advantages of this type of operation include extremely high efficiency, low maintenance and ability to handle materials that are hot, sharp, sticky. According to the company, the units are also adaptable to such processing operations as drying, heating, cooling, separating and blending while they convey.

Aircraft Hydraulic Pump

Adel Div. of General Metals Corp., 10777 Van Owen St., Burbank, Calif, has announced a new high pressure, motor driven hydraulic pump for aircraft. Designated No. 28430, the pump is said to require 25 per cent less amperage and to effect a weight reduction of more than 30 per cent.

The unit's rated pressure is 3000 psi with a rated capacity of 0.5 gpm in an ambient temperature range of sea level to 60,000 ft.

Continued on Page 46



RADIATOR TANK made of Formbrite shown before polishing and after chromium plating. Halves are assembled with a lock seam and soldered together with baffles inside. Intake spout, overflow tube and connecting fitting are also attached.

New fine-grain drawing brass cuts rejects from 13% to under 1%

These radiator tanks—used in a leading sports car—were first made of ordinary drawing brass.

But Morrison Steel Products Company, Buffalo, N. Y., found this brass wasn't stiff enough after forming. During handling, polishing and plating, many dents and nicks appeared on the surface. Rejects ran at about 13%.

Then Morrison turned to Formbrite* — Anaconda's new fine-grain drawing brass. Here's what happened.

1. Rejects dropped to less than 1%.
2. Appearance of the final plated tank (very important in a sports car) was so much improved that now Formbrite is specified for all these tanks.
3. Polishing costs were sliced almost in half.

WHY MORRISON FOUND FORMBRITE BETTER, CHEAPER TO USE

Formbrite has a superfine grain. Produced by special methods of rolling and annealing, this grain is *so fine* that often a simple color buff brings it to a bright, lustrous finish. (Compare magnification of Formbrite Drawing Brass with that of ordinary drawing brass. At right.)

Formbrite is harder, stiffer, springier and more scratch-resistant. It resists denting and deforming. Yet Formbrite is surprisingly ductile . . . readily stamped, formed, drawn and embossed. And Formbrite plates beautifully.

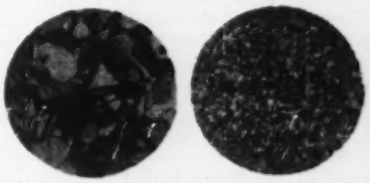
NO EXTRA COST

Premium price for this premium metal? Not at all. Formbrite costs not a penny more than ordinary drawing brass. It comes in sheets, strips and coils—in all commercial widths and gages.

FREE SAMPLE

The way to find out about Formbrite is to try it yourself. Ask for a sample and more information. Just write to: *The American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

*Reg. U. S. Pat. Off. 6487



75x magnification of ordinary drawing brass. 75x magnification of superfine-grain Formbrite.

Formbrite

FINE-GRAIN DRAWING BRASS
an ANACONDA® product

Made by
THE AMERICAN BRASS COMPANY

Just Published

1954 REVISIONS of these AMERICAN STANDARDS

SPINDLE NOSES for Tool Room Lathes, Engine Lathes, Turret Lathes, and Automatic Lathes

B5.9 **$1.75**

Contains complete dimensions of each size and type of nose, of mating backs of chucks, face plates and fixtures, and of gages for checking their important dimensions. Permissible tolerances are specified. Each type of spindle nose is described, and recommendations are given for its use for different types of lathes.

SPINDLE NOSES AND ADJUSTABLE ADAPTERS for Multiple Spindle Drilling Heads

B5.11 **$1.00**

Includes general dimensions of assembly as well as the detail dimensions of adjustable adapter body; set screw slot, adjustable extension adapters, adjustable adapter set screw and friction lock nuts, and spindle noses.

CHUCKS AND CHUCK JAWS

B5.8 **$1.00**

These dimensions are for chucks used on engine lathes, tool room lathes, turret lathes and automatic lathes and fit American Standard Spindle Noses. Classes covered are medium and heavy duty chucks with master jaws of tongue-and-groove type, heavy duty chuck with serrated master jaws, and two-jaw chucks with master jaws of the slip-jaw type.

MACHINE PINS

B5.20 **$1.00**

Types of pins for which dimensions are given include dowel (hardened and not hardened), straight, taper, clevis, and cotter. Drilling specifications for taper pins are given, also a drill chart for size of drill and number required.

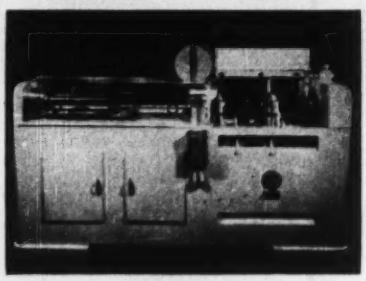
20% Discount to ASME Members

Published by

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 W. 39th St. New York 18, N.Y.

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS



Diaphragming Machine

An automatic diaphragming machine for primer bodies has been announced by Walsh, Inc., 646 N. Michigan Ave., Chicago 11, Ill. The unit is designed to lacquer the interior of the primer body; punch from roll of paper, form and install diaphragms; seat diaphragms to required depth; eject the finished piece and eject an incomplete or rejected piece.

The machine is of steel fabricated construction with removable sides and lucite cover over the cylinders. An interlocking electro-pneumatic circuit has been provided which operates air motors and rotary index table, controlled by mico-switches.

Primer bodies are hopper fed into the machine and will accommodate bodies from 3 to 24 in. in length at a speed of 20 to 50 pieces per minute, depending on the length of the primer body.

End-Mounting Motors

A new end-mounted fractional horsepower motor, equipped with a special new grease for increased bearing life, has been announced by the General Electric Company's general purpose component motor department, Schenectady 5, N. Y.

The grease gives long lubrication with little maintenance, according to company engineers, and aids the ball bearings to absorb heavy end-thrust loads easily. New synthetic slot and between-phase insulation of "Mylar" polyester film, Formex wire and Glyptal varnish make stator windings highly resistant to heat, aging, moisture, and electrical stresses, the engineers said. Ventilation with a large, cast-aluminum fan produces a quiet, effective cooling system.

The new motor is available in open, and totally-enclosed, fan-cooled models, NEMA size 56C face mounting. The capacitor-start and polyphase open models are designed for operation of close-coupled centrifugal pumps. Mounted either vertically or horizontally, they are suited for continuous or intermittent operation, according to company engineers.

The totally-enclosed, fan-cooled model is designed for applications located in dirty or unfavorable conditions, such as machine tools, compressors, pumps, and materials handling systems, engineers said. Both models are available in ratings of 1/4, 1725 rpm, to 1 hp, 3450 rpm.

AIRCRAFT ENGINEERS with Experience WANTED AT GRUMMAN

LAYOUT DESIGNERS
Airframe Structures
Equipment Installations

FLIGHT TESTING
Planners
Analysts

HYDRAULICS
Systems Design
Testing

STRUCTURES
Stress Analysis
Static Testing

RESEARCH
Computer Engrs-Digital or Analog
Vibration & Flutter Engineers
Dynamic Analysis-Systems Engineers

ARMAMENT INSTALLATION
AERODYNAMICS
INSTRUMENTATION
STANDARDS ENGINEERS

TOOL DESIGNERS
TOOL PLANNERS

Recent Graduates with Aeronautical, Mechanical, Civil or Engineering Physics Degrees may qualify

Proof of U. S. Citizenship required

APPLY IN PERSON OR SEND RÉSUMÉ TO:
Engineering Personnel Dept.
INTERVIEWS AT
Employment Office
South Oyster Bay Road,
North of Railroad
Monday thru Friday
8:30–11:30 AM; 1:30–3:30 PM

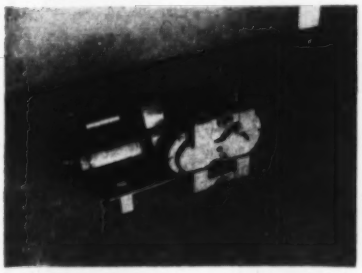
GRUMMAN AIRCRAFT
Engineering Corp.
Bethpage, N. Y.

Flame-Resistant Panels

Resolite Corp., Zelienople, Pa., manufacturer of translucent structural panels of fiberglass-polyester resins, announces the availability of "Fire-Snuf", a self-extinguishing sheet for application in skylighting in industrial buildings, schools and other institutional buildings.

The new flame-resistant panels are molded with "Hetron," a self-extinguishing resin manufactured by Hooker Electrochemical Co. The company says the panels have a flame spread rating under 75, which is in a bracket termed "slow-burning" by Building Officials Conference of America, Inc.

Under the heat and flame of a blow-torch, the new material will burn but extinguishes itself immediately upon removal of the source of flame and heat. The material is molded in all standard roofing and siding corrugations and sheet sizes. It costs a few cents more per square foot than the standard polyester resin sheet.



Diaphragm Pump

The Perry Co., Waco, Tex., has announced a diaphragm pump designed for pumping abrasive liquids, petroleum, liquid food products and chemicals.

The company says the unit, Model 80-50, affords high volume and pressure under adverse conditions, is self priming and will operate dry without harm to the pump. The unit's capacity at 50 lb head pressure is 700 gpm. Pump speed is 483 rpm. Fluid inlet and outlet is $1^1/_4$ in., and the pump is powered by a standard general purpose $^1/_2$ hp 110–220 v, single phase a-c capacitor start motor.

Automatic Slag Breaker

United Conveyor Corp., Chicago, Ill., has announced a new device which mechanically and automatically breaks and knocks down slag formation in pulverized coal fired slagging or wet bottom type furnaces with continuous discharge of molten ash.

The company says the unit is particularly suited to pressurized furnaces where access to the slag neck is limited for manual lancing. The slag breaker is also said to be desirable for negative pressure slagging furnaces to eliminate frequent inspections and labor for breaking down slag accumulations.

The unit has an air cylinder mechanism which is timer controlled and adjusted so that the slag breaker is operated approximately every three to four minutes to break and knock down stalactites that hang from the furnace bottom outlet. Water discharges continuously through the spray holes in the slag breaker pipe to cool the molten slag stream. In the operation of the breaker, the company says, some molten slag will adhere to the breaker pipe and this accumulation is removed when the slag breaker pipe contacts the water cooled stationary cleaning bar.

One unit is horizontal for standard installations, and another is of the crank type for applications where structural interferences make it necessary to lower the mechanism a substantial distance below the furnace outlet.

Combination Data Recorder

Ampex Corp., 934 Charter St., Redwood City, Calif., has announced a dual-channel data recorder developed primarily to meet the requirements of missile test facilities and other applications in which data is telemetered to the recorder.

One channel of the unit is available for recording of data that is in pulse-width modulated form, and the other for direct recording of frequency-modulated signals. The unit has a pulse width response from 60 to more than 1,000 microseconds and a frequency response from 300 to 70,000 cycles per second.

Data is recorded on two parallel tracks on a quarter-inch magnetic tape. Each track, the company says, can be used singly, or both tracks can be used simultaneously. When only one of the tracks is required, the other can be used to record a continuous timing reference.

The company has issued a product specification sheet that lists the advantages of tape, suggested applications and a general description of the unit, accessories, auxiliary equipment, and general performance characteristics and specifications.

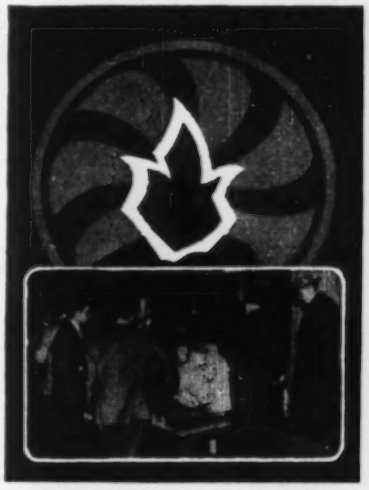
Gas Powered Trucks

The Baker-Raulang Co., 1230 W. 80th St., Cleveland 2, Ohio, has announced the addition of two new gas powered fork lift industrial trucks to its line. They are called FD 50 and FD 60 and are designed to speed the handling of materials in manufacturing plants, warehouses and other rugged outdoor terrain.

According to the company, the FD 50, rated for loads up to 5000 lb, and the FD 60, rated for loads up to 6000 lb, can do a day's work on less than 5 gal of gas per day. Unique electric transmission makes this economy possible. The trucks have Worm-Gear Driven Power Axles to deliver high efficiency under heavy loads when maximum power is needed. In one step only, worm gearing achieves the required speed reduction.

Inching Control on the trucks is said to permit high speed hoisting at low travel speeds. Controlled by the foot pedal, it effects resistance in the generator shunt field, causing reduction in voltage to the drive motor.

More than 2,000 answers to your heating, ventilating and air conditioning PROBLEMS



12TH INTERNATIONAL HEATING & VENTILATING EXPOSITION

Air Conditioning Exposition

COMMERCIAL MUSEUM
PHILADELPHIA

JANUARY 24-28, 1955

That's what you'll find at the 12th Air Conditioning Exposition when over 400 leading manufacturers in these fast-growing fields will demonstrate over 2,000 new and improved products. There'll be answers to your technical problems on installation and use of conditioning systems in all types of structures. See the latest developments in equipment, practices and materials on display in this 5-day concentrated effort to provide you with the best ideas for economical and efficient modernization.

PLAN NOW TO ATTEND

Look for your answers from exhibits, demonstrations, technically qualified personnel, comparisons of competitive products, on-the-spot cost estimates, available technical data and in other time-saving, cost-saving ways. Bring your associates to this source of quick and complete information.

Under the auspices of the American Society of Heating and Ventilating Engineers
Management: International Exposition Co.

WOULD

YOU LIKE

TO HELP

DEVELOP . . .

Nuclear ***propulsion?***

If you are an engineer or scientist who wants to get in early on the age of nuclear propulsion, this may be exactly what you have been looking for.

On this project, you will be working on one of the most challenging problems of today — the development of a nuclear-powered aircraft engine. You will be engaged in a creative-type of engineering where there will be every chance to gain professional recognition.

You will work within the continental United States for Pratt & Whitney Aircraft — world's foremost designer and builder of aircraft engines. You will have all the advantages of this progressive organization — the advancement opportunities — the chance to build a sound, well-rewarded career.

If you are an . . .

Engineer • Metallurgist
Chemist • Physicist

. . . please send your resume immediately to Mr. Paul Smith, Dept. N-6.

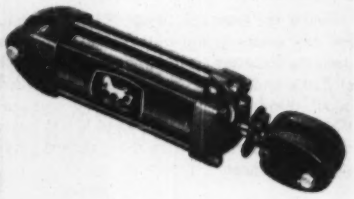
PRATT & WHITNEY AIRCRAFT
Division of United Aircraft Corporation
East Hartford 8, Connecticut

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Speciality Fastener

Shur-lok Corp. announces another new specialty fastener, the SL 1029 overheat switch insulator self-locking nut for use in high temperature applications. This two-piece assembly has a ceramic coated cap and a self-locking insert that is pressed into the cap. It is designed to withstand temperatures to 1500 F.

Specifications, prices and delivery information are available from Shur-Lok Corp., 9010 Bellanca Ave., Los Angeles 45, Calif.



Heavy Duty Ram

The Char-Lynn Co., 2834–26th Ave., S., Minneapolis 6, Minn., announces a heavy duty Strokontrol ram incorporating an easily adjusted accurate hydraulic depth stop.

The thumb-screw collar on the piston rod can be set at any desired position to stop the retracting stroke at the given point until the collar position is changed, company engineers point out.

This ram is said to utilize high strength aluminum alloy castings for light weight and has a hard chrome plated piston rod, blocked V-seals, and a mirror-like honed barrel for precision operation and long life. The cylinder has a $3^1/_2$ in. bore, and is available in stroke lengths up to 16 in. Designed for operating pressures up to 1200 psi, it meets SAE and ASAE specifications governing hydraulic cylinders.

Steam Cleaners

A new line of Hypressure Jenny steam cleaners, known as Series "1800", is announced by Homestead Valve Mfg. Co., Coraopolis, Pa.

Each of the nine models in the line features 180 gal per hr steam cleaning capacity for removing heavy deposits of grease and dirt from machinery, equipment, trucks, parts. Two of the models are available with fingertip control of flushing and rinsing capacity up to 480 gal per hr.

Said to be designed especially for extra-heavy duty cleaning jobs, and for either single gun or two gun operation, the Jennys offer a choice of oil-fired or gas fired units in either stationary or portable type. For field use, or anywhere that electric current is not available, units are offered with gasoline engine drive in place of electric motor. The units have automatic electric ignition, and are said to be able to generate steam-cleaning pressures within two minutes from a cold start. Full facts and specifications will be supplied by the manufacturer upon request.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Welded Grating

Dravo Corp., Machinery Division, 1203 Dravo Bldg. Pittsburgh, Pa., announces the addition of a new type of welded grating to its nationally distributed line of grating and stair treads. Known as Tri-Forged welded grating, this product is of all-welded, one-piece construction with rectangular openings. It supplements the company's nationally distributed line of interlocked grating.

According to the company, the new welded grating was developed by the Tri-Lok Co., Pittsburgh, which manufactures the product. The grating is constructed with double triangular cross bars permanently welded to rectangular bearing bars to produce one-piece construction. The special design of double triangular cross bars was the outcome of research which proved this cross section to be an ideal geometrical shape for pressure welding, the company says, because it provides uniform pressure at all points of the V-contact during the welding operation.

Air-Water Separator

A new device said to simultaneously perform the twin functions of water separation from water-sealed vacuum pumps exhausts and control of exhaust noise, has been announced by Burgess-Manning Co., Libertyville, Ill.

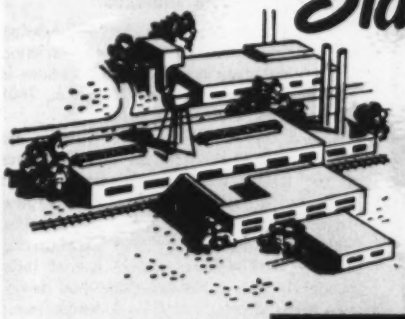
The company reports this is the first device of its kind. Both water and air enter the side of the separator snubber and are separated centrifugally within the unit. The water-free air is then discharged at the top of the snubber and water leaves the unit at the bottom. The WSS separator snubber allows for handling of water having a percentage of settlings and other impurities, and can be cleaned conveniently when necessary, the company states.

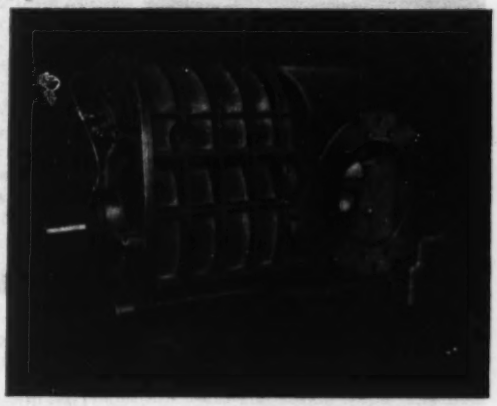
Although water separation is the prime purpose of the unit, it also reduces the discharge noise from the vacuum pump sufficiently for most commercial installations, according to the company. For critical installations where optimum silencing is required, a standard snubber may be installed anywhere in the line leading from the water separator snubber.

Standard units range from 6 to 26 in. in diam, weigh from 8 to 415 lb and handle from 60 to 4,700 cfm.

GIVE ENOUGH
SOON ENOUGH

Standardaire® Blowers





deliver more air in less floor space, and with less noise

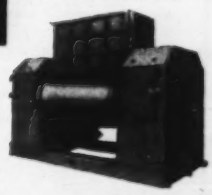
There is no need for heavy, reinforced flooring, foundations or piping anchors if you install a *Standardaire Blower*. The *Standardaire* handles a wide range of volume compression without pressure surges, and with an exceedingly low noise level.

The *Standardaire Blower* achieves its highly efficient operation by employing a proved principle of compressing air or gas on a modified adiabatic cycle. Compactly designed, the *Standardaire* moves more air with less wear, maintenance and power costs. Write today for Bulletin B-154.

READ STANDARD CORPORATION

BLOWER-STOKER DIVISION
370 Lexington Avenue
New York 17, New York

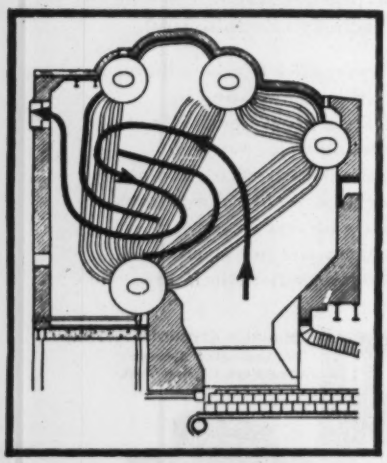
Read Standard also manufactures a complete line of chemical mixers for laboratory and industrial use. For further information write, Read Standard Corp., York, Pa.



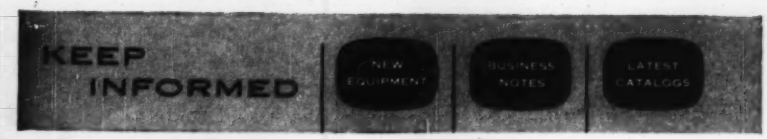
These important fuel-saving, maintenance-reducing features are obtainable with Enco boiler baffles — *and only with Enco baffles.*

- **Streamlined gas flow**
- **Uniform gas flow**
- **Elimination of bottle necks**
- **Reduced draft losses**
- **Higher heat transfer**
- **Cleaner heating surfaces**
- **Less use of soot blower**
- **Special provision for expansion**
- **Easy tube replacement**
- **Adaptable to any water-tube boiler, fired by any fuel**

Each application is designed on the basis of more than a quarter century of experience in this specialized branch of power engineering. Installations are made by skilled mechanics.



THE ENGINEER CO.
Enco 75 West St. New York 6, N. Y.



Heavy Duty Cam Clutches

A new line of extra heavy duty ball bearing overrunning clutches for indexing, backstop and general duty machinery applications is now available from Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

Called the K Series, these clutches are said to embody many of the design features of the former Kelpo overrunning clutches made by Morse for several years. Typical drive applications for Series K clutches, which have a toothed inner race driving member that actuates closely spaced independently sprung cams, include dual drives, two-speed drives, centrifugal water pump drives, forced and induced fan drives, and ventilating fan drives in power plants, mines, steel mills, foundries and other heavy industries.

Tapped holes are provided in both ends of the clutches, for attaching sprockets, gears, pulleys or ratchet arms for drive requirements from 1300 to 6000 ft-lb. Company engineers say that desired direction of rotation is thus easily obtained by attaching the component to either side of the clutches.

Pipe Strainers

Features designed to minimize maintenance difficulties are incorporated in a new line of cast semi-steel Y-type pipe strainers developed by Armstrong Machine Wks., Three Rivers, Mich. The new strainers are for use in steam, air, water, oil and gas lines at pressures to 250 lb. There are eight sizes from $^1/_4$ through 2 in.

Straight bushing threads instead of pipe threads ease removal of bushing and screen, according to company engineers. A copper-asbestos gasket is positioned between the base of the bushing and the body to eliminate the possibility of gasket blowout. Type 430 stainless steel corrosion-resistant screens are standard, either perforated with 225 holes of .045-in. diameter per square inch or 20 × 100 mesh wire cloth. Screens of other materials available on special order. Literature is available from the manufacturer.

Motorized Shaker

Development of a large vibration exciter said to be capable of operating in altitude chambers and over a wide range of temperatures and pressures has been announced by The MB Mfg. Co., Inc., New Haven, Conn.

Electromagnetic in operation, the new model provides a force output of 3500 lb, and has a frequency range of 5 to 2000 cps. This force is unaffected by high and low temperature conditions. The company states that the major axial mode of the equipment unloaded is above 2000 cps. Power is furnished by either rotating or electronic power supplies.

One of the features incorporated in the shaker is the optional mounting on a motorized dolly to facilitate handling and quick placement of the equipment for vibration tests. With its built-in jack, the shaker can be raised from the dolly and lowered onto the floor if desired.

Miniature Motors

Three styles of miniature electric motors for use in actuators or for other high speed applications are available from Pacific Div., Bendix Aviation Corp., 11600 Sherman Way, North Hollywood, Calif.

Motor No. 452008 is a split series type 24 v d-c or 110 v a-c rated at 2.5 oz in. for intermittant duty to 160 F. The motor is available for unirotational and reversible operation and can be supplied with or without integral filter. Weight is 13 oz and the overall dimensions are 3 × 3 × $2^1/_2$ in.

A "square" motor type No. 1007690 designed to AN-M-40 and MIL-E-5272 is rated at 4 oz in. torque, intermittant duty to 165 F. This is a split series 24 v d-c motor. It is available for unirotational or reversible operation and with or without a magnetic brake. Size is 1 in. square by 2 in. long. The model is also manufactured for use in ambients up to 275 F.

A third motor No. 406046 is a shut field type 24 v d-c unirotational only. It is rated at 1 oz in. for continuous duty to 160 F. The motor incorporates thermistors in the field to compensate for temperature effect on motor speed. Weight 13 oz.

Casting Design

The Geo. P. Reintjes Co., 2517-19 Jefferson St., Kansas City 10, Mo., announces a new type casting design said to provide for expansion of the refractory tiles in all directions.

The design utilizes arcuate castings placed on steel tubes which are suspended from the steelwork with U-bolts. The arcuate castings are not bolted to the supporting steel but have freedom for movement horizontally should horizontal expansion of the tiles occur.

Company Engineers say that because all of the castings in the design are free to move horizontally, erection of the nosing is a fast and simple procedure; oversize or undersize tiles are easily compensated for by shifting or sliding the castings on the tubes from which they are suspended. Shearing of the castings is eliminated and mechanical spalling of the refractories, whether clay or basic is greatly reduced.

Continued on Page 52

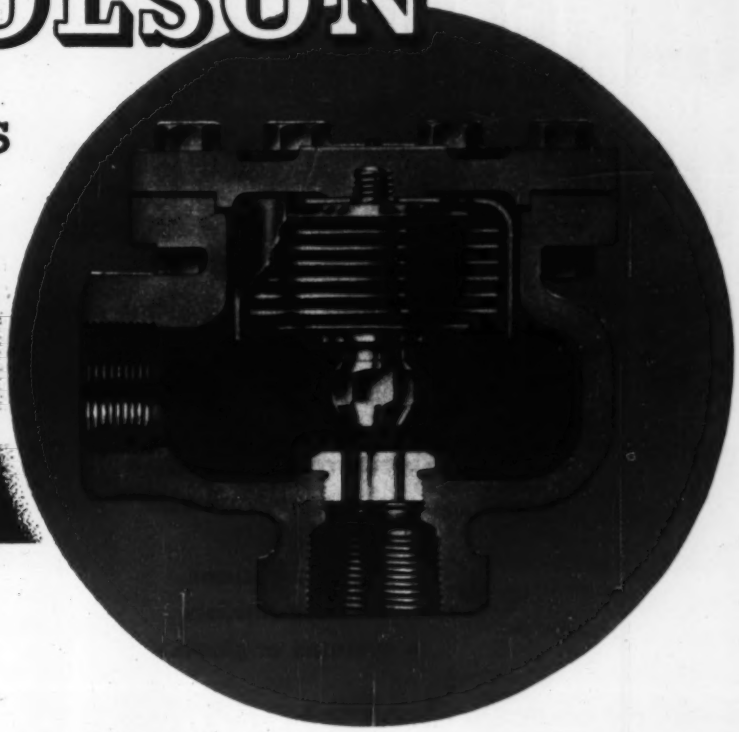
THE UNITED WAY

NICHOLSON

Steam Traps feature

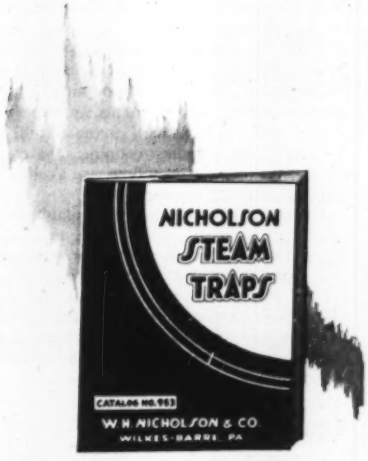
LESS parts

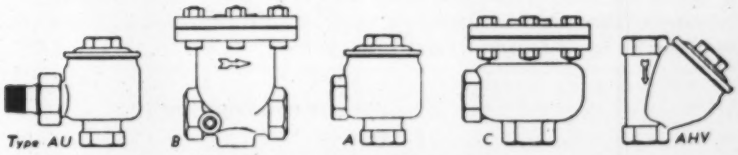
MORE capacity



Note the extreme simplicity of Nicholson industrial steam traps. The heavy-duty bellows integral with valve is the only moving part -- a substantial factor in their low maintenance cost. See also the larger valve orifice. This noteworthy feature results in Nicholson's 2 to 6 times average drainage capacity.

A recent survey showed the features following also to be reasons why plants with standardization-for-economy programs are increasingly adopting Nicholson traps: (1) Operate at lower temperature differential; fast action keeps equipment full of live steam; higher temperatures. (2) No air-binding; eliminate costly fluctuation of operating temperatures. (3) Freeze-proof; freely installed outdoors. (4) No need to change valves for varying operating pressures. (5) Record for low steam waste; as little as 1%.





FIVE TYPES FOR EVERY PROCESS, HEAT, POWER USE

Bronze, semi-steel or cast steel construction. All 5 types have stainless steel valves and seats; bronze, monel or stainless steel bellows. Sizes, ¼" to 2"; pressures from vacuum to 250 lbs.

SEND FOR TRAP CATALOG 953

This 32-page standard reference is complete with installation diagrams as well as charts and formulae for determining proper size of trap.

W. H. [redacted] & CO.

TRAPS · VALVES · FLOATS

219 OREGON ST., WILKES-BARRE, PA.

Sales and Engineering Offices in 58 Principal Cities

CAREER OPPORTUNITIES FOR . . .

- mechanical engineers
- electronics engineers
- electrical engineers
- physicists
- mathematicians
- aerodynamicists
- systems engineers

SANDIA CORPORATION, a subsidiary of the Western Electric Company, operates Sandia Laboratory under contract with the Atomic Energy Commission. Sandia engineers and scientists work at the challenging task of designing and developing atomic weapons. Graduate engineers and scientists, with or without applicable experience, will find excellent opportunities in the fields of component development, systems engineering, applied research, testing, and production.

COMPENSATION is competitive with that offered in other industry. Ingenuity and initiative are valued highly, and opportunities for professional advancement are outstanding. Working conditions are excellent, and employee benefits are most liberal.

SANDIA LABORATORY is located in Albuquerque — a modern, cosmopolitan city of 150,000, rich in cultural and recreational attractions and famous for its excellent year-around climate. Adequate housing is easily obtained. For descriptive literature giving more detailed information on Sandia Laboratory and its activities — or to make application for employment — please write:

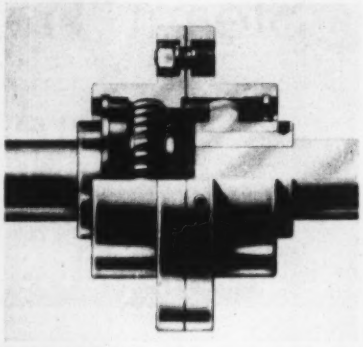
professional employment
division 1B

SANDIA Corporation

Sandia Base
Albuquerque, New Mexico

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS



Spherical Coupling

Philadelphia Gear Wks., Erie Ave. and G. St., Philadelphia 34, Pa., announces the Sphereflex coupling, designed to offer industry a coupling having gear teeth which are cut on a segment of a sphere at competitive price levels with regular couplings.

The male teeth of each coupling half are cut on a true spherical arc while the internal teeth are cut with a straight root. Thus, the company says, whenever misalignment occurs, the curved tooth maintains a constant area of contact with the internal tooth, and coupling flexibility is not dependent upon excessive backlash between coupling teeth, point contact or springs.

Teeth of the coupling are of uniform thickness from side to side. Regardless of the nature of the misalignment there is always complete line contact between the coupling teeth—while point contact is never possible, the company's engineers say. They point out that no thrust load on bearings can develop through the coupling.

While the Sphereflex coupling will compensate for all types and combinations of misalignment, the standard coupling is suitable for angular misalignments up to $\pm 3^1/_2$ deg on each coupling half, giving a total of ± 7 deg for the standard coupling, the company says. Special couplings are available, suitable for 14 deg misalignment.

The standard couplings are available from stock in sizes 0 through 6 (maximum bore $6^3/_8$ in.) while larger couplings for steel mill and other heavy duty service are made to order. Also a complete selection of floating shaft and vertical couplings using the Sphereflex principle are available. An eight-page catalog, No. C-540, describing the coupling is available from the company.

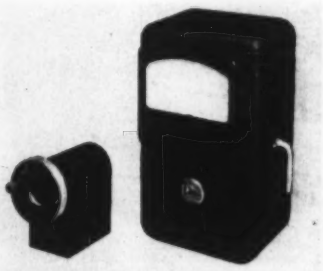
Expansible Resins

A series of expansible resins for silicone foam structures are now available from Dow Corning Corp., Midland, Mich., in the form of "ready-mix" powders. Containing premeasured proportions of resin, filler, blowing agent and catalyst, the mixes melt, foam and cure by themselves when heated. No further mixing or processing is required, the company says.

Non-toxic, easily handled and unaffected by humidity or atmospheric pressure, the

mixes can be cast into sheets or blocks, made up as sandwich structures, or foamed in place. According to the company, only negligible pressure is exerted during expansion, so that molds may be light weight and do not require preheating. Density can be controlled from 8 to 18 lb per cu ft by varying the expansion temperatures, and, in many applications, the foam can be post-cured in service.

Three separate mixes are currently available in commercial quantities. Identified as R-7001, R-7002 and R-7003, they produce a graduated range of mechanical strengths at elevated temperatures. Finished foams are characterized by a uniform, spherical, unicellular pattern. All remain stable at as high as 700 F and exhibit good physical and electrical properties, low moisture absorption and thermal insulating values in the range of .3 Btu per h per sq ft per deg F per ft.



Photoelectric Pyrometer

Photoswitch Div., Electronics Corp. of America, Dept. P 194, 77 Broadway, Cambridge 42, Mass., announces the development of a photoelectric pyrometer for industry designed to make possible the precise monitoring and control of the temperature of hot materials.

The control operates from the amount of infra-red radiation emitted by the hot object, and since the radiation increases proportionally with the temperature, a constant indication is given of the heat of the material being scanned. Through a fast-acting relay, the heat applied to the material can be closely controlled at any point throughout the range of the set. Since no part of the equipment touches the hot object, the system is ideal for measuring the temperature of objects that are moving, or are surrounded by induction heating coils, or are in any way difficult to measure by conventional means.

Suggested applications for the unit include induction heating, forging processes, molten iron and steel, welding operations, upsetting processes, wire drawing, rolling mills, kilns, laboratories, industrial ovens, smelters, open hearth furnaces, header machines, glass processing.

The complete system comprises two units: a scanner Type 41AU4 consisting of a phototube and lens assembly with a variable iris, and a control Type 27LJ7 containing an electronic amplifier, a relay and a meter. As the temperature of the hot object being

This man can help you with your design plans involving bellows or bellows assemblies

M. G. CALHOUN
one of our staff of bellows application engineers.

HE CAN SHOW you how a bellows assembly can do the job. He will work with you on the bellows design . . . advise you on the metal required—brass, stainless steel, monel or nickel. He will recommend the correct bellows charge—volatile liquid or gas.

He'll help you on many more factors that will make your design plans more efficient. You'll be assured of a bellows assembly *exactly* suited to your needs—to help your products perform as planned.

There are many uses for Sylphon and Bridgeport bellows assemblies—for thermostatic devices, pressure controls, hydraulic mechanisms, expansion joints, motion transmission, as flexible connectors and in more applications.

Let our engineers, our half-century of experience and ample production facilities work for you—save you time, money and trouble. Get full information. Write today.

SEND FOR FREE BULLETIN

Idea-filled Bulletin tells you all about metal bellows and bellows assemblies. Send for your free copy today. Ask for Catalog XK-1400.

Robertshaw-Fulton
CONTROLS COMPANY

FULTON SYLPHON DIVISION
KNOXVILLE 1, TENNESSEE

BRIDGEPORT THERMOSTAT DIVISION
BRIDGEPORT 1, CONNECTICUT

JOIN RCA ENGINEERING MANAGEMENT

RCA has two engineering management openings in its expanded electronics engineering program:

Administrator Mechanical Design (*to coordinate design effort of Engineering Staff for best practical mechanical design*).

Manager Airborne Fire Control Product Design (*to supervise design engineering of airborne electronic equipments*).

These positions require the ability to manage a comprehensive design and development engineering organization and to plan broad engineering programs. Your ability should be substantiated by proven supervisory experience and a degree in EE, ME, or Physics.

Send a complete resume of your education and experience to:

Mr. John R. Weld, Employment Manager
Dept. B-483L, Radio Corporation of America
Camden 2, New Jersey

RCA **RADIO CORPORATION OF AMERICA**

Engineers

Your Move

The men we seek are experts in their specialized fields, capable of filling responsible engineering positions with MELPAR, a leader in research and development. Perhaps one of these men may be you. We invite you to learn about our long-range military and industrial programs.

If you are experienced in one or more of the fields listed below, write us about yourself and let us tell you during a personal interview about our past record of success and how you can successfully fit into our future plans.

- Network Theory
- Microwave Techniques
- UHF, VHF, or SHF Receivers
- Digital Computers
- Magnetic Tape Handling Equipment
- Pulse Circuitry
- Radar and Countermeasures
- Microwave Filters
- Flight Simulators
- Subminiaturization Techniques
- Electro-Mechanical Design
- Photo Equipment Design
- Packaging Electronic Eqpmt.

Technical Personnel Representative

melpar, inc.

A Subsidiary of the Westinghouse Air Brake Co.

452 Swann Ave., Dept. M5-12 Alexandria, Virginia
or 11 Galen St., Watertown, Mass.

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

scanned rises, the increase in radiation is indicated on the meter which can be calibrated in degrees for the particular application. In addition, the heavy duty control relay can be set to operate at any temperature within the range of the set.

A sensitivity adjustment allows the point at which the relay operates to be pre-set, providing automatic control of signal devices or of the heat applied to the hot object The variable iris of unique design will cut down the radiation reaching the phototube, allowing the equipment to respond accurately even to the highest temperatures. In addition, an instrument such as an Esterline-Angus Recorder (zero to 1 milliampere) can be connected into the circuit to provide a continuous chart of temperature variations.

Automatic Control

A pneumatic control for the Speed-Trol, variable speed transmission, has been announced by Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.

The Conoflow pneumatic control utilizes a Cono motor and provides an automatically controlled drive for processing operations involving variables such as pressure, temperature, liquid level, proportional flow and control of rewind, the company's engineers say. The control is available in both manual and automatic types which are sensitive to many types of electric, mechanical or pressure signals.

The company says the control is one of the innovations for speed changing that can be applied to the Speed-Trol. The infinitely variable speed transmission has finger tip control of speed change, positively displaced variable pitch diameter pulleys, especially designed variable speed V-belt. It is available in either standard or special electrical characteristics, in single, double and triple reduction gear combinations with a wide variety of mounting options. Each type of Speed-Trol with gears can be mounted without modification on floor, wall or ceiling with shaft horizontal or vertical, the according to the company.

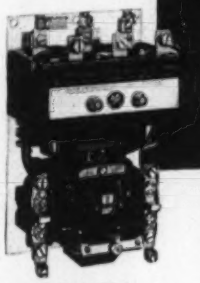
Continued on Page 57

PRECISION LIMIT SWITCHES

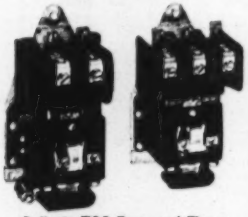
SPECIAL CONTROL PANEL

OILTIGHT PUSH BUTTON STATIONS

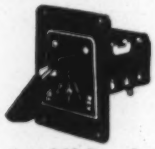
Quality A-B MOTOR CONTROLS for Automatic Machines



Bulletin 709
Solenoid Size 3 Starter



Bulletin 702 Two and Three
Pole Size 1 Contactors



Bulletin 350 Drum Switch
for Flush Mounting

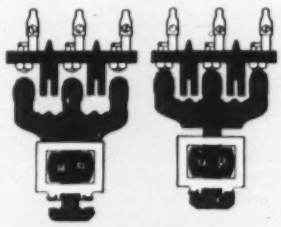
Bulletin 800T Oiltight
Selector Switch

When you sell your machines fully equipped with automatic motor controls, make these controls a featured sales asset. Standardize on a line . . . like ALLEN-BRADLEY . . . having a world-wide reputation for QUALITY . . . and you can guarantee "complete" customer satisfaction.

Independent industry-wide surveys list ALLEN-BRADLEY controls at TOP preference among machinery users. In test after test ALLEN-BRADLEY motor controls are the first choice of designers, shopmen, and electricians. They like the simple A-B design and trouble free operation. They like the fine A-B appearance. They like the big line of A-B accessory controls that solve so many control problems so easily. They like the all around A-B "Quality."

We shall be glad to send you the Allen-Bradley Handy Catalog. Please write for your copy, today.

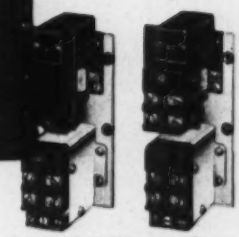
The reason for the trouble free performance of Allen-Bradley solenoid starters is the simplicity of design. There is but ONE MOVING PART . . . the ONE PIECE solenoid plunger which carries the double break moving contacts (shown in red).



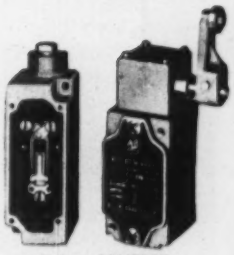
SIMPLE—
Only One Moving Part

The double break fixed contacts are mounted in the molded contact block (shown in black).

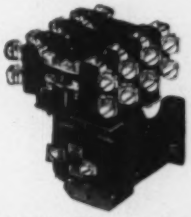
The cadmium silver moving and stationary contacts need no filing, cleaning, or dressing. They are good for millions of switching operations.



Bulletin 849 Pneumatic Timer
Adjustable—1/6 to
180 Seconds



Bulletin 801-802T
Limit Switches



Bulletin 700 Universal A-C
4-Pole Relay

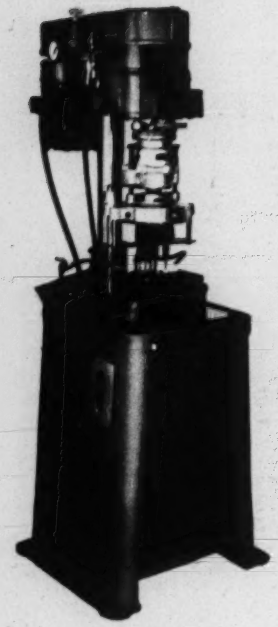
Bulletin 892 Terminal Blocks
for Special Control Wiring

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Limited—Galt, Ont.

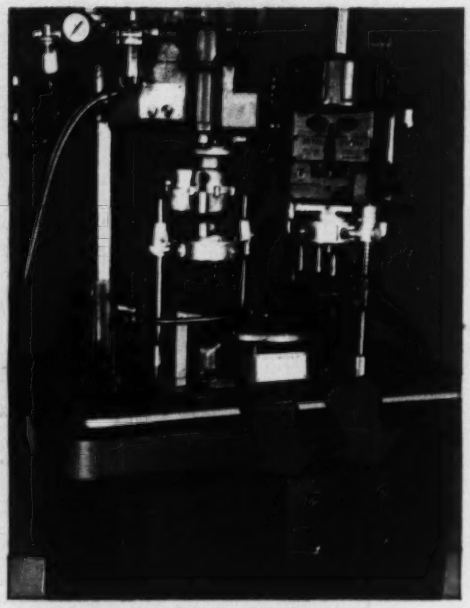
ALLEN-BRADLEY

QUALITY

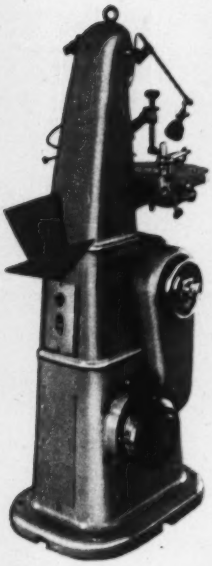
9-54-R



Ettco single spindle tapping machine with manual flush starter.



Ettco multiple spindle drilling and tapping machine with two Allen-Bradley Bulletin 609 manual flush type motor starters.

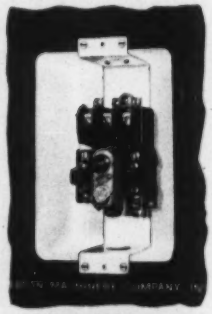


Williams punch and die making machine with A-B flush type starter.

Improve the appearance of your machines with A-B flush type motor starters

When contemplating the design of a new machine, take advantage of the opportunity to "streamline" your design by recessing into the base of the machine at least the starter—and perhaps this can also be done with the motor.

Look at the trim appearance of the three motorized machines shown above. Note how the designers have provided recessed cavities for flush type Allen-Bradley Bulletin 609 manual motor starters.



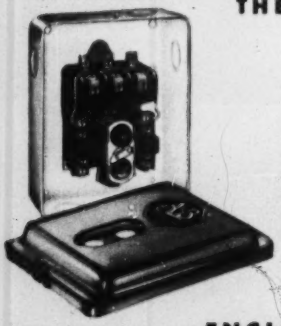
Bulletin 609 manual starter in machine base

These flush type motor starters give a smooth, modern appearance to the machines and, therefore, provide a "sales value" that can be used to advantage.

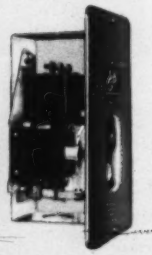
Allen-Bradley Bulletin 609 manual starters, Bulletin 709 automatic starters, and Bulletin 712-713 combination starters can be furnished in several types of flush mountings. They are fully described in the Allen-Bradley Handy Catalog. Send for a copy, today.

THE LINE OF BULLETIN 609 MANUAL STARTERS

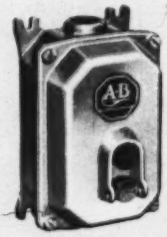
General purpose with white interior



Flush type



Weatherproof & waterproof



Explosion proof

Single phase

ENCLOSURES FOR EVERY OPERATING CONDITION

9-54-R

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. In Canada—Allen-Bradley Canada Limited—Galt, Ont.

ALLEN-BRADLEY

BULLETIN 609 MANUAL STARTERS

Quantity Control Valves

A line of quantity control valves said to eliminate the severe hydraulic shock accompanying rapid cut-off of large-volume flows has been introduced by Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.

The valves are available in 6, 4, 3 and 2-in. sizes and are designed to be used in conjunction with a Rockwell developed multi-stage register latching device on Rotocycle meters. The meters have rated capacities of 20 gpm minimum to 800 gpm maximum for the 2 to 6-in. sizes.

Rapid closure with only relatively slight increases in pressure is one of the outstanding operating characteristics claimed for the valves. Closure time varies from $7^1/_2$ sec for the smaller, to $12^1/_2$ sec for the larger sizes. In each case, closure is accomplished in three stages, each lasting a few seconds.

The company says the valves are expected to have wide application in the refinery and marketing operations of the petroleum industry. The 6-in. size is especially adapted for the automatic filling of field storage tanks, sea-going tankers, barges, railroad tank cars and large transport trucks.

The 3-in. and 4-in. valves are particularly suitable for use in loading tank trucks at bulk plant terminals, the manufacturer reports.

Computer Introduced

A new instrument designed to meet the needs of intricate applications where close computing accuracy is required has been developed by the Taylor Instrument Cos. Called the Transet computing relay, it is claimed to be capable of adding, subtracting, averaging and ratioing. Up to three separate pneumatic input presssures with an accuracy of .5 per cent can be bandled by the computer, the company says.

The company recommends the instrument for any process where two or three different signals must be compared and where variables are required to maintain a constant relationship to each other. The relay is a pneumatic force-balance transmitter whose output is linear to any input pressure changes.

Additional information is available from the company, 95 Ames St., Rochester 1, N. Y.

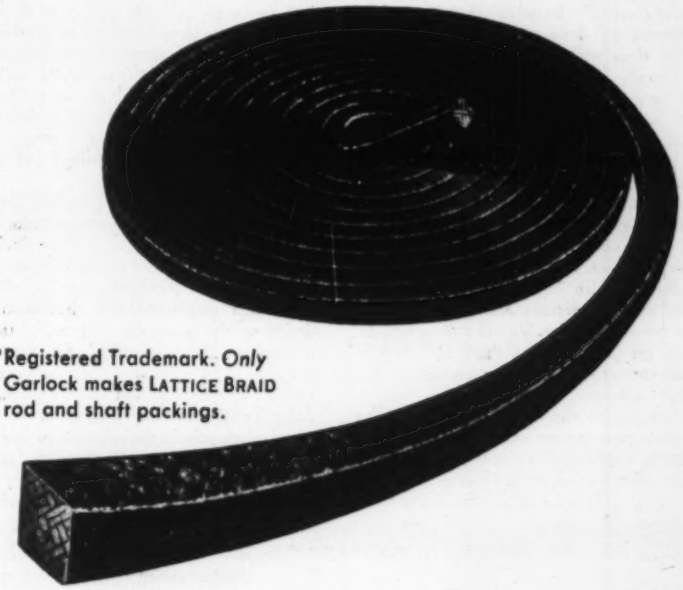
Use a
CLASSIFIED
ADVERTISEMENT
for Quick Results

Users report that

LATTICE BRAID*

ROD AND SHAFT PACKING

has these 5 advantages



*Registered Trademark. Only Garlock makes LATTICE BRAID rod and shaft packings.

1. Requires *less* gland pressure
2. Causes *less* sleeve and shaft wear
3. Retains lubrication *longer*
4. Does *not* unravel; thus makes better, more uniform rings
5. Lasts *much* longer than ordinary braided packings

Put Garlock LATTICE BRAID Packing to work for your company. All the braided strands of this unique packing are lattice linked together into one structural unit. The strands hold together even when the packing is worn far beyond the limits of wear of ordinary braided packings.

LATTICE BRAID is made from flax, cotton, asbestos, wire-inserted asbestos, Teflon, and asbestos with Teflon impregnation—for various types of services.

Get all the facts about LATTICE BRAID *Packings. Contact your Garlock representative or write for new folder AD-131.*

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Cleveland Denver • Detroit • Houston • Los Angeles • New Orleans • New York City • Palmyra (N. Y.) • Philadelphia Pittsburgh • Portland (Oregon) • Salt Lake City • San Francisco • St. Louis • Seattle • Spokane • Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK LATTICE BRAID PACKING

Universal Line of Pullers

Blackhawk Mfg. Co., Milwaukee 46, Wis., announces a complete line of 127 Pullers and Pulling Attachments to fill all maintenance requirements.

The company says new 2- and 3-arm pullers spread to hold up to 36-in. diam. and have capacities up to 50 tons. A special "power-pitched" buttress thread enables mechanics to develop 30 per cent more torque than with standard thread, claims Blackhawk. Lips of pulling arms are reversible for inside and outside pulling, and basic parts are interchangeable between corresponding sizes of 2- and 3-arm pullers. Threads are precision cut to fit tight with perfect alignment. Cocking or biting into shafts is eliminated because the pullers equalize the strain and pull even so the most stubborn part will come off easily and quickly. Where puller jaws can not be used, matched pulling attachments with thin, knife-like jaws can be forced behind bearings and gears to apply the force of the puller. Sheave pulling attachments are said to have thick lips that fit snugly into grooves to pull gears and wheels without damage.

According to the company the line also includes push-pullers which, with special adaptors, push or pull with capacities up to 35 tons. Interchangeable legs can be moved to accommodate any desired center. Legs are available in different lengths and threaded on the ends to screw into pulling attachments. All Blackhawk Pullers are either cadmium or chrome plated.

Surface Roughness Scales

New cylindrical surface roughness scales, designed as a standard of comparison by sight and touch for internal and external curved surfaces, have been developed by the General Electric Co.'s instrument, Schenectady 5, N. Y. Consisting of two scales each, six in. wide and two in. long, the set is ideal for determining the roughness of surfaces produced by grinding, lapping, honing, superfinishing, turning, boring, drilling and others, according to G-E engineers.

Surface roughness on both scales is specified by numbers stamped on the units' sides which represent the arithmetic average deviation from the mean surface in microinches. The scales provide a standard objective reference by which engineers and draftsmen can designate the roughness and appearance of numerous finishes required for functional purposes. In addition, the scales can be utilized by planners and shop mechanics in determining processing procedure, the engineers claim, and in the selection of tools and equipment necessary to produce specific finishes required by specifications.

Variable Speed Drives

Cleveland Worm & Gear Co., 3249 E. 80th St., Cleveland 4, Ohio, announces a speed variator available in 9 sizes, ranging from 1/2 to 10 hp at 1750 input rpm.

Power is transmitted from the input shaft to the output shaft through alloy steel driving balls which are in pressure contact with disks attached to the two shafts. Relative speeds of the two shafts are adjusted through a 9:1 range (from 1/3 to 3 times the input speed) by changing the angular positioning of the axles on which the balls rotate. According to company engineers, the result of this simple arrangement is an infinitely variable and stepless range of output speeds from one constant speed power source.

Operating efficiencies of 75 to 90 per cent are easily maintained over a wide range of operating conditions, the company says. Coaxial input and output rotate in the same direction, either clockwise or counterclockwise.

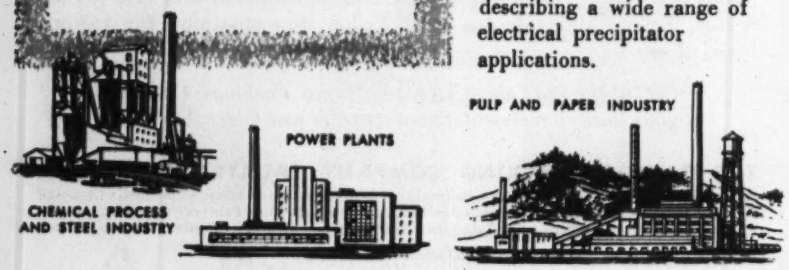
Compact Coolant Pump

A new H-6000 series immersion type centrifugal coolant pump has been introduced by Graymills Corp., 3705 N. Lincoln Ave., Chicago 13, Ill., to embody space saving possibilities never before obtainable with "big pump" performance. The H-6000 pump is compact in its design, fitting the modern trend of compactness in all types of machine tools, yet it delivers 17 gpm at 12 ft head with water. It is designed to handle liquids, even containing abrasives, through a wide range of viscosity with ample reserve horsepower to prevent overloading the motor to cause pump failure.

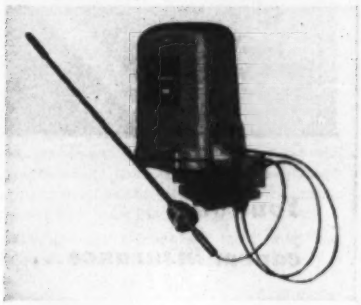
The H-6000 series comes in two standard immersion lengths—6 1/2 in. and 8 1/2 in. for all types of machine tools, machinery and for any special application. There is no metal to metal contact between moving parts and the shaft and moving parts are enclosed and protected by the pump casting. A new catalog sheet is available from the company showing dimensions, performance data and installation instructions.

Industry looks to
RESEARCH -COTTRELL
for high dust collection efficiencies

To maintain visually clean stacks at all times, industry is turning to the long experience of Research-Cottrell in the design and manufacture of highly efficient Cottrell Electrical Precipitators. We've spent 40 years in solving such problems as nuisance abatement, cleaning gas for subsequent use and recovering materials of value. Write for illustrated bulletin describing a wide range of electrical precipitator applications.



RESEARCH-COTTRELL, INC.
A WHOLLY OWNED SUBSIDIARY OF RESEARCH CORPORATION
Main Office and Plant: Bound Brook, N. J.
405 Lexington Ave., New York 17, N. Y. • Grant Building, Pittsburgh 19, Pa.
228 N. La Salle St., Chicago 1, Ill. • 111 Sutter St., San Francisco 4, Cal.



Process Measurement

An instrument which accurately measures process temperatures and pneumatically transmits the information to a central recording or controlling station has been announced by the Foxboro Co. of Foxboro, Mass. Known as the Model 12A temperature transmitter, it is a nonindicating device of the "force balance" type with a calibrated accuracy of $\frac{1}{2}$ per cent of the temperature span and compensated for ambient temperature and barometric pressure variations.

The transmitter is designed around a gas filled thermal system which exerts force on a flapper-nozzle mechanism in proportion to the measured temperature. The resulting back pressure in the nozzle circuit, amplified through a relay and converted to a force through a bellows, quickly balances out the initial force and constitutes the 3-15 psi output transmitted by low cost tubing to the receiving instrument.

Spans ranging from 50 F to 400 F are available and can be utilized between the limits of −100 F and +1000 F. Three and a half feet of Geon-protected capillary tubing connects temperature bulb to transmitter. A block and clamp mounting arrangement rigidly secures the seven pound instrument to any vertical or horizontal pipe or to a flat surface.

Floating Gearmotor

A floating Gear motor has been developed in response to the need for a roll or conveyor drive which would be entirely self-contained and be located at the point where the power was required by Philadelphia Gear works, Erie Ave. and G. St., Philadelphia 34, Pa. The company says the unit reduces power transmission to its simplest terms. It is mounted directly on the driven shaft to eliminate misalignment between the power unit and driven shaft. A simple torque arm prevents the gear unit from rotating.

The floating Gearmotor can be mounted in almost any location or position. It has a right angle worm and worm gear arrangement to permit the entire unit to nestle close to the driven machine, and is proportioned for 300 per cent peak loading over normal ratings. Housing construction is cast steel or cast iron as required. An eight-page catalog, F-54, describing the floating Gearmotor is available from the company.

6000-Pound Crane Truck

Designed for transporting long, hard-to-manage loads in confined areas, and to reach into normally inaccessible areas, a 6000-lb capacity crane truck has been developed by the Elwell-Parker Electric Co., Cleveland, Ohio.

The crane has a travel speed of 4 mph without a load, and $3\frac{1}{2}$ mph with full load. Hoist speeds: Up, without load—28 fpm, with full load—14 fpn; Down, without load—15 fpn, with full load—26 fpm.

Company engineers say the crane is designed with a slewing action to facilitate handling on either side of the travel area without additional movement. A separate motor drives a grooved drum through worm and planetary gear reduction. An electric limit switch stops travel at the extreme limits of slew travel.

The boom is telescoping, with built-up heavy channel, and features a rigidly reinforced box type construction with ample bracing. The boom, in a telescoped position, measures 12 ft 6 in.; extended, the boom measures 19 ft 2 in. Boom lengths may be varied to suit specific operating requirements.

The magnet, one of many types of attachments which may be used, receives its power from the battery, or from a gas or diesel-electric generating unit. The crane, when using a magnet, is also equipped with an automatic reel operating device the company points out.

Additional information may be obtained from the company, 4205 St. Clair Ave., Cleveland 3, Ohio.

Feedwater Control

One, two and three element feedwater control systems have been developed by the Hays Corp., Michigan City, Ind. The electronic operation of the controller, the company says, provides great speed of transmission and high accuracy of control and is independent of effects due to normal variations in voltage and frequency.

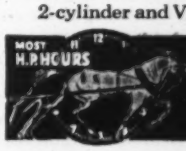
A choice of three systems is offered to meet the requirements of large, medium or small boilers under normal or most severe operating conditions. Present instruments can be utilized and pressures up to 2,500 psig can be accommodated.

Other features include positive valve drive; operative even on cold boilers; mercury-less measuring and transmission for flow and level; direct level measurement; electronic null balance remote operation; independent adjustments for effects of steam flow, water flow and water level; no blow-down necessary.

with this WISCONSIN-POWERED UNIT!

This sturdy unit takes a six-foot-wide bite in any kind of snow, loading from 7 to 12 cubic yards of snow per minute in trucks or throwing it clear. Builder is Krause Industries, Baraboo, Wisconsin and the snow blower is constructed to mount easily and quickly on the Hough Payloader Tractor-Shovel. A Wisconsin Heavy-Duty Air-Cooled Engine provides the power.

Equipment builders and buyers are choosing Wisconsin Engines over all other types in the 3 to 36 hp. range . . . as the most satisfactory and foolproof power to fit both the *job* and the *machine*. You'll find a model and size available to fit every power requirement . . . 4-cycle single-cylinder, 2-cylinder and V-type 4-cylinder models, 3 to 36 hp. Write for Bulletin S-164.



WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46, WISCONSIN

Digital Computer Techniques

Applied to the design, development and application of

Military Radar Fire Control Systems

Aircraft Control and Navigation Systems

Electronic Business Systems

The successful application of Hughes airborne digital computers to high speed aircraft fire control problems has opened up an entire new area for these digital computer techniques.

Similar equipment is now under development in the Advanced Electronics Laboratory to apply such digital systems to modern business information handling.

Areas include

LOGICAL DESIGN
COMPONENT DEVELOPMENT
PROGRAMMING
MAGNETIC RECORDING
CIRCUIT DESIGN
INPUT & OUTPUT DEVICES
SYSTEMS ANALYSIS

Engineers and Physicists

Computer activities embrace systems planning and analysis, design and development, system engineering and component development. Experience in these areas, as well as in application of electronic digital computers, is desirable but not essential. Analytically inclined men with backgrounds in systems work are required for this phase.

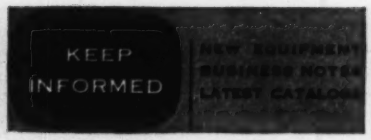
Scientific and Engineering Staff

Hughes

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, Calif.

Assurance is required that relocation of applicant will not disrupt an urgent military project.



Ball Bearing Trolley

A new line of ball bearing trolleys for overhead conveyors is covered in a 20-page book, No. 2536, announced by Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill. It contains specification data for the selection of new trolleys, or of replacement trolleys for existing installations.

The trolleys, known as Series 500, are for use on 3, 4 or 6-in. I beams. Two types are available: bolted wheel and bracket assembly, for ease of assembly and disassembly; and riveted, for permanent assembly. Special trolleys such as electrified and heavy duty foundry trolleys, are also illustrated. The booklet includes application and maintenance information and a description of the attachments commonly used, and 12 illustrations of typical overhead trolley installations.

Quadrant Orifice Plate

Taylor Instrument Cos. has added a quadrant orifice plate to its line of flow measuring elements. It will be offered as a part of the company's line of calibrated orifice elements.

The quadrant orifice has a rounded approach on its upstream face in contrast to the usual sharp edge to make it insensitive to viscosity changes so long as the throat Reynolds Number does not exceed 250,000. According to the company, extensive tests indicate that this type of orifice can be used with liquids where the throat Reynolds Numbers are as low as 500. The sharp edge orifice shows predictable performance changes in the band of 15,000 to 50,000 and its performance becomes a good deal less predictable for values less than 15,000. In contrast to this, the quadrant type orifice has, for all practical purposes, a constant coefficient over the Reynolds Number range of 500 to 250,000 it is claimed.

The quadrant type of orifice is recommended primarily to measure flow of fluids whose viscosities vary.

Additional information is available from the company, 95 Ames St., Rochester 1, N. Y.

Split Hydraulic Transmissions

A split hydraulic transmission especially adaptable to textile machinery requirements is now available from Vickers Inc., 1400 Oakman Blvd. Detroit 32, Mich. Completely sealed and self-lubricated, these drives, the company claims, provide cost-saving advantages through long life and absence of troublesome continuous maintenance.

Components of the split hydraulic transmissions are standard units selected to meet the operational requirements of such textile machinery as slashers, pickers, dye becks and continuous washers. According to the company engineers the pump, motor and appropriate valving are combined to provide an efficient positive displacement type fluid power transmission having infinitely variable speed control. Both the pump and the hydraulic motor have controls for regulation of

Your best cancer insurance...

"LIFETIME" POLICY... See your doctor *every year* for a thorough check-up, no matter how well you feel.

"DAY-TO-DAY" POLICY ...See your doctor *immediately* at the first sign of any one of the seven danger signals that *may* mean cancer (1) Any sore that does not heal (2) A lump or thickening in the breast or elsewhere (3) Unusual bleeding or discharge (4) Any change in a wart or mole (5) Persistent indigestion or difficulty in swallowing (6) Persistent hoarseness or cough (7) Any change in normal bowel habits.

Many cancers can be cured, but only if properly treated *before* they have begun to spread or "colonize" in other parts of the body.

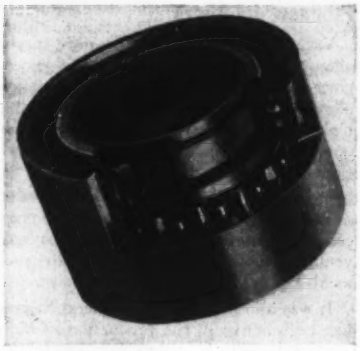
For *any* information about cancer just call the American Cancer Society or write to "Cancer" in care of your local Post Office.

American Cancer Society

output speed and power characteristics. Acceleration and deceleration rates are independently adjustable.

The company says split transmissions are particularly useful where special placement of the hydraulic equipment is desirable, such as separation of hydraulic pump and hydraulic motor to meet space limitations or solve alignment problems. They offer particular advantages where drive requirements demand special combinations of a pump and more than one hydraulic motor.

Standard a-c motors are used with the split hydraulic transmissions.



Cam Clutches

A new line of cam clutches for indexing applications in a wide variety of machinery drives is now available from Morse Chain Co., 7601 Central Ave., Detroit 10, Mich. Designated as series HT cam clutches, this new line of self-contained units includes a single row ball bearing that helps maintain concentricity of the inner and outer races.

Series HT clutches are designated for application on stepped shafts in machinery drives. The customer supplies a standard snap-ring ball bearing for supporting the opposite end of the unit, which has an outer race bore ground to fit the outside diameter of standard single row snap-ring ball bearings. According to the company, typical applications include general duty over-running and backstop operations, feed rolls, spring coilers, metal forming equipment, dual drives, and two-speed applications.

The new series feature constant pitch spacing, alternate cam and roller construction. The clutch cams are a specially designed shape to avoid cam roll-over under peak or torsional loads. Low locking angles on the cam faces are said to assure self-energizing action of each cam. An auxiliary energizing spring insures energizing of all cams under light loads and varying conditions.

Use a CLASSIFIED ADVERTISEMENT
for Quick Results

Audio Generator

An extended frequency range, improved amplifier and the addition of an output attenuator and voltmeter are new features on the type 1304-B beat-frequency audio generator introduced by General Radio Co., 275 Massachussetts Ave, Cambridge 39, Mass.

The output frequency extends from 20 cycles to 40,000 cycles in two ranges with a calibration accuracy of ±(1 per cent + 0.5 cycle). Frequency dial, with logarithmic calibration, can be coupled directly to recorder. Synchronous motor dial drives are also available.

The output amplifier uses the new single-ended push-pull circuit and supplies one watt into a 600-ohm load with less than 0.25 per cent distortion between 100 and 10,000 cycles, according to the company.

The audio generator provides a calibrated output voltage. Output level is indicated by a meter and an attenuator setting, in both volts and dbm. Full-scale, open-circuit output voltages of 50 mv, 500 mv, 5 v, and 50 v are provided with a basic voltmeter accuracy of ±5 per cent of the voltmeter reading.

Butterfly Valves

Builders-Providence, Inc., a division of B-I-F Industries, Inc., 345 Harris Ave., Providence, R. I., has announced that it is extending its line of butterfly valves to include rubber-seated, tight-closing butterfly valves for general service. According to the company, utilitarian design and rugged construction are combined for positive, trouble-free performance in these valves which meet the American Water Works Association's tentative standard specifications for rubber-seated butterfly valves, AWWA C504-54T. Accessories include manual, electric, hydraulic and pneumatic operators.

Builders-Providence representatives in the United States and Canada will handle the valve sales. Bulletins and technical data are available from the company.

Magnetism Recorder

General Electric Co., Schenectady 5, N. Y. has developed a new device said to do away with hours of laborious measurement and calculation to determine the magnetic characteristics of metal.

Called a d-c recording hysteresigraph, it traces the magnetic signature of a metal directly onto a scaled chart in a matter of minutes. The usual method of obtaining the same information requires long calculation, using data gathered from sensitive ballistic galvanometers. The hysteresigraph is able to compile and calculate these data with the use of two fluxmeters which integrates the flux voltage continuously.

Nine different sensitivities in the hysteresigraph range from a full scale reading of 0-2000 interlinkages to 0-1,000,000 interlinkages. These enable the accurate measurement of materials ranging from ferrites to high permeability nickel iron alloys.

Plan Now for the 4 biggest days in radio-electronics!

I R E National Convention and RADIO ENGINEERING SHOW

March 21-24
New York City

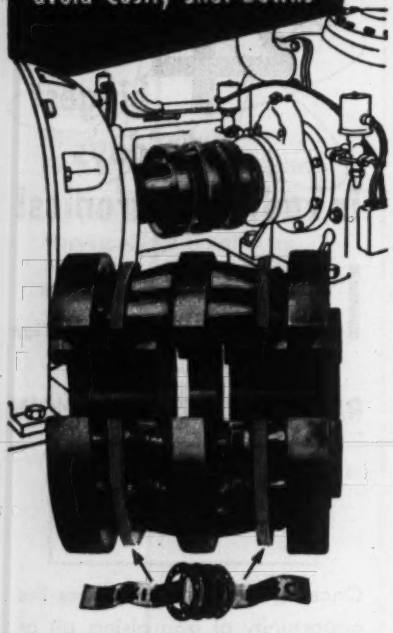
Once again, you'll soon have the opportunity of appraising all of the important new developments of the past year in radio and electronics. In 4 days, from March 21 through 24, the I R E National Convention and Radio Engineering Show will give you the complete picture of significant developments in the industry achieved during the past year.

You'll hear the presentation of scientific and engineering papers of vital interest to you, carefully arranged into related groups of technical sessions.

You'll see more than 700 exhibits in a 4-acre panorama of all that's new in the radio and electronics field, at Kingsbridge Armory and at Kingsbridge Palace.

The Institute of Radio Engineers
1 East 79th Street, New York City

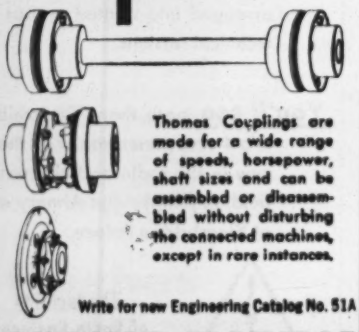
Specify THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

DISTINCTIVE ADVANTAGES

FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Thomas Couplings are made for a wide range of speeds, horsepower, shaft sizes and can be assembled or disassembled without disturbing the connected machines, except in rare instances.

Write for new Engineering Catalog No. 51A

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

KEEP INFORMED — NEW EQUIPMENT — BUSINESS NOTES — LATEST CATALOGS

Multi-Purpose Fastener

Townsend Co., New Brighton, Pa., has announced development of a new multi-purpose fastener with a one-piece metal washer-head and assembled neoprene washer for use in preventing leaks, for protecting surfaces, absorbing shock and stopping squeaks. It is called Tuff-Tite.

When the new fastener is seated, the company says, an undercut in the washer head traps and controls the flow of the neoprene at the outside edge, forming a perfect water-tight and air-tight seal.

Use of Tuff-Tite in the construction field provides water-tight fastening of galvanized steel, protected metal, stainless steel, aluminum, plastic and other roofing and siding construction materials.

The fasteners have been approved by the U. S. Department of Agriculture for use in grain storage bin construction.

The neoprene washer also acts as a shock absorber to prevent squeaks and chatter in railroad passenger cars, automobiles and heating ducts where vibration noise is a problem. According to the company, the washer, in the appliance field, provides a cushion for the fastener and permits tight seating without marring porcelain enamel and other fine surfaces which must be blemish-free.

The fasteners are said to provide greater assembly speed, simplify inventories and reduce labor costs. The lower profile gives a neater appearance. Leaks between the head of the fastener and metal washer are eliminated since they are one piece.

Neoprene washers can be pre-assembled and applied to self-tapping screws, thread cutting screws, drive screws, stove bolts, machine screws, wood screws, nails and special products. The fasteners are available in stainless, carbon and alloy steel as well as many non-ferrous materials, such as aluminum and copper. Screw diameters smaller than No. 6 (.140 inches) are not recommended fasteners.

New Thermostat in Regulator

Temperature regulators containing a new type thermal element have been developed for use on internal combustion engines and other temperature control applications by the Fulton Sylphon Div. of Robertshaw-Fulton Controls Co., Box 400, Knoxville, Tenn. The new regulators are supplied with three-way valves.

Changing over from the conventional liquid or gas-filled thermal element, the new regulators contain an unusual Power-Pill unit, which is charged with a solid, wax-like compound, the company explains. When subjected to heat the special wax-like compound imprisoned in the unit melts and expands, generating an extremely powerful force by comparison with older thermostatic units. The heated liquid returns to a solid state upon cooling.

The new regulators are insensitive to internal pressures of the system in which they are installed, an important performance factor where systems are under pressure. They are considerably smaller in size and lower in cost than existing regulators for similar applications. The regulators contain from one to four Power-Pill units, depending upon the size of the valves, which are available in sizes ranging from 2 and 6 in.

All repairs, replacements of parts, and adjustments can be made without removing the valve from the pipe line, it was stated. Temperature settings are available in the range from 120 F to 190 F in 10 to 15 deg increments, and may be altered by changing units.

Produces Jet Alloys

Vacuum melted, high-temperature special alloys for turbine wheel buckets of jet engines and other applications, headed by a new alloy said to be capable of withstanding higher temperatures than any wrought alloy now in production, are being produced on a commercial basis by Carboloy Dept. of General Electric Co., Detroit, 32, Michigan.

The new jet alloy has stress rupture properties superior to those exhibited by conventional wrought turbine bucket alloys such as M-252 and S-816, the company says.

It was also revealed that General Electric has been active in the production of high-temperature metals at the research labora-

Aeronautical or Mechanical Engineers

For development of

GUIDED MISSILES AND ROCKETS

Applicants must have obtained their Masters, Professional, or Doctors Degree since 1945 and be between 20 and 35 years of age. Work involves theory and application in such fields as:

- **Mechanics and Dynamics**
- **Fluid Dynamics**
- **Structural and Mechanical Design**
- **Heat Transfer and Thermodynamics**
- **Systems Analysis**

Send summary of qualifications to:

CALTECH
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena 3, California

tory in Schenectady for the past eight years, and that, to date, the company has produced about 100,000 lb of the special alloys, specifically for its Aircraft Gas Turbine Div.

Carboloy's position as the manufacturing and marketing outlet for metallurgical products of the parent company, and the intense interest in new high-temperature materials, both within and outside the company, brought about the decision to enter the specialty alloy circle of producers, the company stated.

Initial output, according to the announcement, will be from a pilot plant comprising a 400-lb vacuum melting furnace, capable of producing 100,000 lb of high-temperature alloys annually. Vanadium-Alloys Steel Co., Latrobe, Pa., will continue to convert the 400-lb ingots produced by the pilot plant into bars, strip, sheet and other shapes.

It is expected that within a short time high-temperature resistant alloys of nickel or cobalt-chromium base, hardened with molybdenum, tungsten, carbon, titanium and aluminum will be produced to withstand temperatures of over 1600 F, according to the company.

Solenoid Valves

Automatic Switch Co., 391 Lakeside Ave., Orange, N. J., has announced a new line of solenoid valves designed for use in controlling the flow of air, gas, water, light oil and other non-corrosive fluids. The valves are available normally closed or normally open, with standard, watertight or explosion-proof solenoid enclosures.

Designed to fit pipe sizes of $^3/_8$, $^1/_2$, $^3/_4$ and 1 in., the normally open valves are said to have a maximum pressure of 250 psi on air. Normally closed valves are rated 200 psi on air. All metal parts in contact with fluids are brass or stainless steel. The company says class A coils are supplied as standard and class H glass silicone insulated coils and luxolene molded coils are available.

The valves are designed for use on all standard a-c and d-c voltages. Power consumption is 10 w. Form 708, covering the new line, is available from the manufacturer.

Electronic Test Unit

A new portable, self-contained, electronic test device for vibration and shock analysis has been marketed by the York Div. of the Bendix Aviation Corp., York, Pa.

The company says the unit represents a big advancement in stroboscopic observation—the use of a synchronized light source to observe the effect of vibration and shock on many of today's industrial products. The device is called Flash-Lok and is designed to eliminate time-consuming adjustments required of former methods to synchronize the speed of light flashes with the vibration of the object being tested, the company says.

Excitation for the device is derived directly from electrically driven vibration equipment, or from an accelerometer attached to mechanical equipment. The light source flashes at a one- or five-cycle rate differing from the vibrating base in order to observe either slow motion, for detailed study and analysis, or fast motion for general detection or resonances. The light flashes may also be locked exactly to the vibration frequency if desired.

Synchronization of the light source at the difference frequency with the vibrating base is maintained automatically throughout the operating frequency range of 30–2000 cps. The unit is furnished with one 1D21 flash lamp, reflector and connecting cord as standard equipment. Space is provided in the instrument cabinet for storing the lamp when not in use. Provisions have also been made to operate a second 1D21 should the need arise. A jack is provided for connection of commercially available white light sources when extra brilliance is required.

The unit weighs less than 21 lb and measures only $9^1/_2$ in. high, $8^1/_4$ in. wide, and $12^1/_2$ in. deep. It operates from a standard 115-v source and requires 65 w of power.

Industrial X-Ray Unit

MG 60 fluoroscopy and radiography unit for industrial inspection, production control and scientific purposes that is self-contained, light-weight and easily portable, has been announced by the research and control instruments div., North American Philips Co., Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.

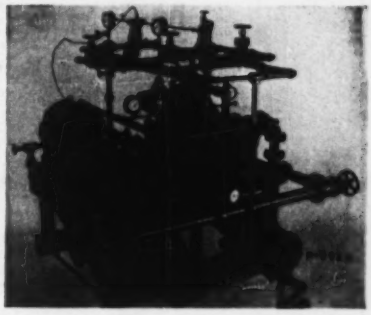
The unit detects metallic foreign matter and locates contact parts and connectors in insulating materials, helps in the control of fabric layers in rubber, and reveals metallic contents of luggage, parcels in customs and police offices. It is recommended for use in the packaged food industry by the company.

The unit is designed for continuous operation. The X-ray tube has a small focal spot, 1mm.

It takes power from 110 or 220 v, a-c. Current consumption is approximately 2 am and permissible continuous output is 4 ma at 60 Kvp. The X-ray unit is 17 × $8^3/_8$ × $8^3/_8$ in. and weighs 46 lb. Control unit is $8^1/_4$ × $6^3/_8$ × $5^1/_2$ in. and weighs 14 lb. Fluoroscopi box is 16 × 22 × $23^1/_4$ ins. and weighs 50 lb.

COMPLETE RANGE OF SIZES AND MODELS IN BOTH MEDIUM AND HIGH PRESSURE TYPES

MORE COMPACT THAN EVER..



P-952A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

NATIONAL AIROIL

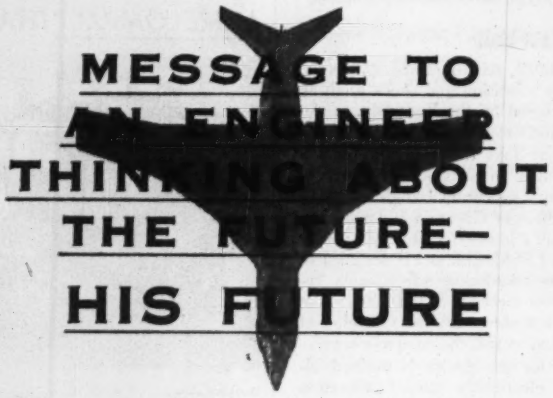
FUEL OIL PUMPING AND HEATING UNITS

NATIONAL AIROIL Fuel Oil Pumping and Heating Units are specially designed to prepare, for combustion, all grades of fuel oil including No. 6 or Bunker "C" Oil and residuums. They will draw fuel oil from above ground or underground tanks, preheat it to proper constant temperature and deliver it to Oil Burners at an even pressure, best suited for the burners. Our Fuel Oil Pumping and Heating Units are the result of years of experience. They come completely equipped ready for steam, exhaust, condensate, oil suction, oil return, and electrical connections. All valves, regulators, etc., are readily accessible. The piping arrangement is easily understood. These compact, space-saving units are available in a range of sizes and models in both Medium and High Pressure types. For complete details, write for our Bulletin 40—very interesting and informative.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
MOTOR-DRIVEN ROTARY OIL BURNERS
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
DUAL STAGE, Combining Steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
FURNACE RELIEF DOORS
OBSERVATION PORTS
SPECIAL REFRACTORY SHAPES

NATIONAL AIROIL BURNER CO., INC.

1239 East Sedgley Avenue, Philadelphia 34, Pa.
Southwestern Division:
2512 South Boulevard, Houston 6, Texas



MESSAGE TO AN ENGINEER THINKING ABOUT THE FUTURE— HIS FUTURE

Take a few moments now to review the progress of your career. Does your present position offer you a future that fully utilizes your creative abilities?

Compare your present assignment with the diversified, stimulating pursuits that increase the inventive challenge of Fairchild's team of qualified engineers. These men are working on engineering advances for the famous C-119 Flying Boxcar and the soon-to-be-produced C-123 Assault Transport. More than that, they are developing tomorrow's jet fighters . . . special reconnaisance aircraft . . . jet bombers and transports. The men at Fairchild know that *planned* project diversification keeps them in the forefront of the field of aerodynamics.

Gracious country living only minutes away from urban Baltimore or Washington . . . paid pension plan . . . an excellent salary with paid vacations . . . ideal working environment . . . generous health, hospitalization and life insurance . . . and the many other benefits of a progressive company add to the pleasure of working with Fairchild.

You'll be investing wisely in a secure future if you take time today to write to Walter Tydon, Chief Engineer, outlining your qualifications. Your correspondence will be kept in strict confidence, of course.

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Aircraft Division
HAGERSTOWN, MARYLAND

Universal and Dual Amplifiers

Two new amplifiers, Model BL-520 universal amplifier and the Model BL-530 dual channel d-c amplifier, have been announced by Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.

The new universal amplifier is a very high gain carrier amplifier that accepts signals from both resistive and inductive transducers. The company claims it will measure and record on a direct writing oscillograph such things as strain, force, pressure, temperature, displacement, vibration, acceleration, and motion.

The amplifier has a maximum sensitivity equivalent to $\frac{1}{2}$ μ v per chart mm, or, for strain measurements, .25 μ in. per in. A d-c medium gain amplifier section with calibrated attenuator may be used eparately for voltage and current measurements, according to the company.

The dual channel d.c. amplifier, will accept both single-ended and differential signals with a 50 mv sensitivity and provides for accurate calibration of the recorded signals.

Both amplifiers provide for balancing out voltages up to 10 times full scale at input signal levels up to 500 v.

Multiple Unit Valves

A new series of compact multiple unit valves designed specifically for mobile machinery service is now available from Vickers Inc., 1400 Oakman Blvd., Detroit 32, Mich.

Designated Series CM 11, the new valves meet the requirements of heavy duty mobile equipment applications. Improved metering characteristics permit greater precision in nudging, crowding, and inching operations, according to the company. The new multiple unit valves are particularly applicable to materials handling equipment, road and construction machinery, farm implements and trucks.

The valves are made up of standardized and interchangeable units assembled in combinations up to 8 sections between special compact combination inlet and outlet units. The new inlet section is a single casting that combines inlet manifold, operating valve and relief valve; the new outlet unit is also a one-piece casting combining outlet manifold, operating valve and end plate. Company engineers say this combined form makes the valve physically smaller than would be possible using all separate sections. Individual end plates are also available for applications involving the use of a single operating valve.

Automatic Blending Process

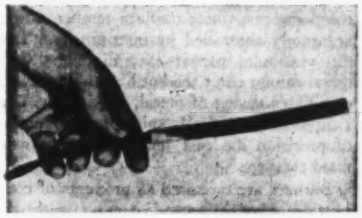
Richardson Scale Co., Clifton, N.J., announces a new remote weight-control system for continuously and accurately blending additives with process material.

Features of the system include the batch weighing of additives, continuous weighing of process material and the remote selection of weight ratios using a single dial control. Advantages claimed by the company are rigid process control, immediate start-up,

quick formula changing, precise weighing of additives, and operation over a wide range of weight ratios.

Products handled include chemicals, foods, feeds, fertilizers, tobaccos, plastics, and cement & rock products. Components of the system are an automatic hopper scale, electric control system, control panel and a constant-weight belt feeder.

In operation, process material drops on the belt feeder and discharges into a mixer. Batches of an additive material are weighed out and automatically discharged into the same mixer. Signal for the discharge of additives is transmitted via an impulser on the belt feeder. Thus, the flow of material leaving the belt feeder determines the rate of discharge of additive material.



Strain Gage

A simple and efficient new embedment type strain gage for concrete is announced by Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. The new gage, known as the Baldwin SR-4 Valore type concrete embedment strain gage, incorporates an SR-4 resistance wire strain gage with an effective length of three inches.

The new strain gage, developed by Rudolph C. Valore, Jr., Materials Engineer, National Bureau of Standards, Washington, D. C., and its performance has been described in the bureau's Circular No. 528. The wire element is sealed in a brass envelope .01 in. thick and .5 in. wide. Its overall length is 6 in. Leads are a twisted pair of solid No. 20 conductor, Neoprene insulated to .125 in. diameter and sealed with wax in an opened end of the brass envelope as protection against moisture in the concrete before it has set.

Two types of gage are announced. One is self-temperature-compensated for mild steel over the range of 0-100 F to correspond with the average coefficient of expansion of concrete. This coefficient is 0.0000065 in. per deg F. The other gage is not so compensated. Both have a gage factor of 2 and resistance of 300 ohms.

Miniature D-C Motor

A new miniature permanent magnet d-c motor, built for extremely long-life operation, has been developed by El Ray Motor Co. of North Hollywood, Calif. Designated the Model 1300-1 gear motor, it is 2.8 in. long, with ano utside dimensional width of 1-1/8 in. Weight of the motor is 4-1/2 oz.

The new model has been especially designed for timing equipment and other applications requiring constant speed under con-

MYCALEX
Announces...
Substantial
Price Reductions
on
Mycalex 410
Telemetering
Commutator
Plates

Increased production of Mycalex 410 Telemetering Commutators now brings new savings to the user. Universally accepted as the finest commutator plate in the field, this precision-built unit injection-molded of Mycalex 410 glass bonded mica insulation assures permanent dimensional stability — provides a tenacious bond to the metal inserts.

Important MYCALEX features—

- no dimensional change with age, humidity or temperature
- contact flatness within .0002"
- permanently high inter-contact dielectric strength
- repeated solderability — no loose contacts under vibration or shock
- high-speed brush means no "bounce" nor hash — provides square wave switching

Revised price lists are available now.
Write for your copy today.

MYCALEX
ELECTRONICS
CORPORATION
Under exclusive license
of Mycalex Corporation
of America

Executive Offices:
30 Rockefeller Plaza,
New York 20, N. Y.

Address Inquiries to
General Offices and Plant:
Dept.126
Clifton Boulevard
Clifton, N. J.

SINCE 1919
MYCALEX
THE INSULATOR

tinuous use. The company says the unit meets or exceeds all applicable requirements of AN-M-40. It may be designed for any input voltage from 6 to 30 volts d-c, has an output of 6 watts maximum for continuous duty or 12 watts maximum for intermittent duty. The output of the motor can be designed for any speed from 1/2 to 9,000 rpm, depending on the gearing installed.

The motor has an aluminum alloy case with plastic molded brush housing. The company says the ball bearings are sealed and greased for the life of the motor, and the armature assembly has been built with a high degree of precision manufacture to insure long life and trouble-free operation. The motor can be supplied with loads or feed-through terminals, and can also be supplied with a governor which increases the length of the motor by 5/8 in. The governor provides a control range of ± 1 per cent for a constant load over ±10 per cent voltage range.

JUST OFF THE ASSEMBLY LINE . . .

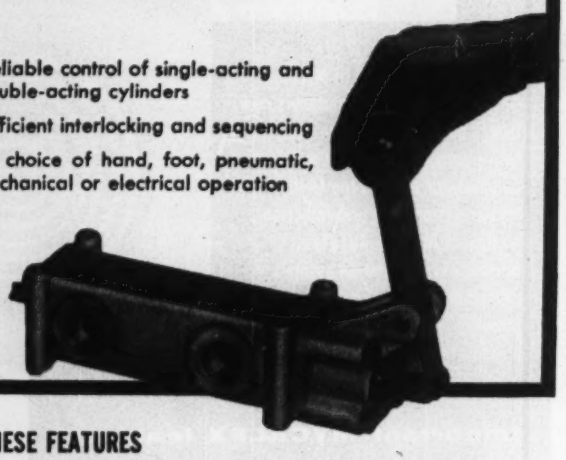
New Flow Valve

WESTINGHOUSE
TYPE D PILOTAIR VALVE

Gives you reliable control of single-acting and double-acting cylinders

Gives you efficient interlocking and sequencing

Gives you a choice of hand, foot, pneumatic, mechanical or electrical operation



YOU'LL LIKE THESE FEATURES

3,125 USES. Every valve is made up from a number of sections that bolt together to give any type of operation.

PRESSURE SEAL STAYS IN THE GROOVE. Completely new Westinghouse seal can't roll out of position . . . will not nick, scar, or chip.

LONG LIFE, LOW MAINTENANCE. No moving metal parts rub against metal. *Valve spool floats on rubber.* Stainless steel spool and aluminum alloy body resist corrosion.

WRITE FOR MORE FACTS
or get in touch with your local Westinghouse Air Brake Co. Distributor. He is listed in the classified phone book under "Cylinders: Air."

Westinghouse Air Brake
COMPANY
Industrial Products Division
WILMERDING PENNSYLVANIA

Pneumatic cylinders, valves, engineered pneumatic systems and air control devices of all kinds.
Factory Branch: Emeryville, Calif. Distributors throughout the United States.
Distributed in Canada by: Canadian Westinghouse Co., Ltd., Hamilton, Ontario.

Aluminum Melting Furnace

A new dry hearth double-chamber melting furnace has been developed by Eclipse Fuel Engineering Co. for quality melting, die casting, or permanent molding of aluminum parts requiring a minimum of porosity.

Basic design consists of separate melting and holding baths in a single unit. The furnace has a high melting rate and uniform pouring temperature. Production per square foot of floor space is approximately 50 per cent higher than that obtained with crucible furnaces, and fuel consumption per pound of metal is 40 per cent lower.

Aluminum is charged through the door into the sloping hearth, and melts at a high rate. Hearth in melting area is designed to allow molten aluminum to flow into the holding compartment, where uniform temperature is accurately controlled by instruments. Two dip vestibules permit easy dipping. Cold metal cannot enter the hot bath. The design eliminates gasing of metal, making the new Eclipse furnace ideally suited for production of precision die cast parts and permanent mold castings.

Burners are mounted so products of combustion have improved contact with the metal without flame impingement. Pilot is integral with main burner. Venting through the arch reduces heat around the furnace. Other construction features include: heavy 4 in. angle main frame construction, convenient side counterweighted doors, non-wetting inner liner and 5 in. insulation.

Furnaces are available in 12 standard sizes up to 2000 lb per hour capacity, for gas, oil or combination gas-oil firing. Dip vestibules may be arranged for end, single-side, or double-side dip out. For further information, contact the manufacturer, Eclipse Fuel Engineering Co., 1002 Buchanan St., Rockford, Ill.

Multichannel Oscillographs

Multichannel direct writing oscillographs featuring four and six channel systems have been announced by Brush Electronics Co. An electrically controlled chart drive system permits instantaneous speed selection. A total range of 16 accurate chart speeds is possible from one centimeter per hour to 250 millimeters per second. All speeds are selected with a front panel control or with an accessory remote control unit.

The same basic chassis, used throughout the series, permits the four channel oscillographs to be expanded to six channels as requirements change. Four or six channel chart paper may be used interchangeably on six channel units.

The Oscillographs can be mounted on roller slides in a standard 19-in. rack or can be furnished in a console for operation on a bench or cart. Both ink writing and combination ink and electric writing units are available. A detailed description may be obtained from Brush Electronics Co., Equipment Dept. RT-1, 3405 Perkins Ave., Cleveland 14, Ohio.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Mortar-Like Conductor

The Chemax Mfg. Corp., a newly-formed corporation, is producing a mixture of powders and a liquid to form a thermal conducting material, marketing it under the trade name of Tracit. It is said to be a mortar-like material which is self-hardening and when set, is highly resistant to mechanical and thermal shock. Because of good heat conduction, it is useful in conducting heat between surfaces, usually irregular in shape.

Tracit, due to its adhesiveness, is easily applied to surfaces by hand or with a trowel. The company claims that after setting by drying, either in air or forced drying, the material bonds strongly to a surface. One suggested use of the material is its application over traced pipe, valves or equipment where it is desirable to maintain a constant temperature by the addition or subtraction of heat. In this use, it is an alternate to the more expensive method of jacketing.

Because of its excellent heat transfer and high compressive strength, Tracit is also recommended by the company for the floors of radiant heated homes or plants where good distribution of the heat in the tubing is desired. Write to the Company, 900 Wilmington Rd., New Castle, Del.

BUSINESS NOTES

Names New Distributor

Chain Belt Co., Milwaukee 1, Wis. has announced the appointment of the Stevenson Machine Co., as a distributor, authorized to sell Chain Belt products in and around Lockland, and Cincinnati, Ohio. Business to be served by this new line of products will be chiefly in the industrial and manufacturing fields. In conjunction with its sales department, the Stevenson Machine Co. also operates a complete machine shop employing 40 people.

Indianapolis Outlet

Insul-Mastic reinforced asphaltic coatings manufactured by Insul-Mastic Corp. of America, 141 Oliver Bldg., Pittsburgh, Pa., are now being sold and applied in the Indianapolis district by Malcolm Builders, Inc. This firm will employ the coatings for resurfacing old, weatherbeaten buildings and for rustproofing steel structures in industrial plants.

Eureka Appointed by Clark

Eureka Boiler Works, Eureka, Calif., has been appointed to sell and service the fork-lift trucks, straddle-carriers and other materials handling equipment manufactured by the Industrial Truck Div. of Clark Equipment Co.

The dealer will handle the Clark line in the California counties of Sisikiyou, Del Norte, Humboldt, Trinity and Mendocino.

Pangborn shows Daystrom

HOW TO SOLVE A DUST PROBLEM

Back in the '30s, when Daystrom Co., Olean, N.Y., expanded into the production of tubular steel chairs and tables, dust became a major problem. Many of the new manufacturing processes created dust, jeopardizing employee health and community goodwill.

Daystrom moved quickly to solve that problem—and Pangborn Dust Control was the solution. Pangborn has implemented good community relations and improved employee health and morale. In addition, Pangborn still saves Daystrom money every year by reducing dust damage to machinery, cutting repair bills and downtime, and lowering plant maintenance costs.

Pangborn can do the same for *you*. Pangborn engineers will be glad to show you how Pangborn Wet or Dry Dust Collectors can solve your dust problem and save you time, trouble and money!

See how Pangborn benefits *all* industries. Write for free copy of "Out of the Realm of Dust," Pangborn Corp., 2200 Pangborn Blvd., Hagerstown, Maryland.

Pangborn
CONTROLS DUST

Install Norblo

to be sure you have worry-free 'round the clock

Automatic Dust Collection

Norblo builds its own blowers in a wide range of capacities.

Norblo also builds centrifugal and hydraulic dust collectors, exhaust fans, cement air cooling systems, and portable type dust collectors.

You can have continuous dust and fume collection at full rated capacity without a worry about maintenance down time. Norblo automatic bag type dust arresters handle heavy loads by faithfully maintaining a constant suction drop across the arrester. Compressed air shakers coupled with air reversal action assure efficient bag cleaning, one compartment at a time.

Norblo engineers the complete installation with ample capacity for your needs, with wide adjustability and all the safeguards you may need. Few moving parts combined with a fully coordinated functional design result in very high efficiency, low cost of operation and maintenance. It will pay you to have Norblo engineers study your requirements. Write for Bulletin 164-4.

Each group of 39 bags has its individual compressed air shaker.

The Norblo Variable Electronic Timer governs the shaking and cleaning cycle.

Any compartment may be cut out of the operation and inspected through access door.

The Northern Blower Company

Engineered Dust Collection Systems for All Industries

6421 Barberton Ave. OLympic 1-1300 Cleveland 2, Ohio

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

50TH Anniversary

Pangborn Corp., Hagerstown, Md., manufacturer of blast cleaning and dust control equipment, recently celebrated its 50th anniversary. Participating in the event, which featured an open house at the company's home plant, was Thomas W. Pangborn, founder and president of the firm.

A tribute program was held, and employes unveiled a bronze plaque honoring the achievements of the president and his brother, John C. Pangborn, first vice president. Theodore R. McKeldin, governor of Maryland, spoke briefly and presented the official tribute of the state honoring the contributions of the company to the economic well-being of the state and its support of religious, charitable, educational, medical and scientific institutions.

Clark Distributor

The newly-formed Wiley Equipment Co., 710 Tenth St., Atlanta, Ga., has been appointed to sell and service the line of fork trucks, straddle carriers and other materials handling equipment manufactured by the Industrial Truck Div. of Clark Equipment Co.

The dealer will handle the Clark products in the Georgia counties north and west of and including the counties of Screven, Jenkins, Emanuel, Candler, Montgomery, Jeff Davis, Coffee, Atkinson and Clinch.

To Build New Plant

Rockwell Mfg. Co. has announced the selection of Russellville, Ky., as the site for a new plant expected to go into operation in mid-1955. The plant will be located on a 30 acre site and will have from 80,000 to 100,000 sq. ft. of floor space. It is expected to cost from $800,000 to $1,000,000 exclusive of production equipment. Construction will start in early January and initial occupancy is scheduled during May.

New Kaiser Distributor

Kaiser Aluminum & Chemical Sales, Inc., announces the appointment of American Brass & Copper Co., 1920 Union St., Oakland 7, Calif., as a distributor of its full line of aluminum rod, bar, sheet products and extrusions. The territory covered by the distributor includes northern California from Fresno north to the Oregon border and east to Reno, Nev.

Facilities for handling the wide range of aluminum industrial products include a new overhead crane installed by American Brass & Copper and a 12-foot shear, a slitter, bar saws and other special equipment for customer service. Special trucks provide two daily deliveries to aluminum users in the San Francisco-Oakland Bay area.

For Consulting Engineers Turn to Page 122

Ampco Distributor

Ampco Metal, Inc., has announced the appointment of the Industrial Supply Co., 451–453 E. Broad St., Hazleton, Pa., as its exclusive distributor in the Wilkes-Barre, Hazleton sales area.

The company will carry a full line of Ampco bronze weldrod products consisting of Ampco-Trode (aluminum bronze) 10, 160, 200, 250, and 300 (a-c or d-c), Phos-Trode and Mang-Trode electrodes. Also supplied will be bare filler rods and coiled wire for the automatic and semi-automatic welding processes.

Centrifugal Pumps

Cameron Pump Div., Ingersoll-Rand, 11 Broadway, New York 4, N. Y., has issued a 16-page catalog covering the company's cradle-mounted centrifugal pumps with capacities of 5 to 2800 gpm at pressures of 10 to 525 ft. total head.

Design and dimension data is diagrammed, and performance data is given in tabular form. Installation and application data is also included in the bulletin.

Tungsten Alloy

A new technical data sheet covering the latest information on machinability and other physical properties of Hevimet, a high tungsten alloy twice as heavy as lead, produced by powder metallurgy, is announced by Carboloy Dept. of General Electric Co., Detroit 32, Mich.

The data sheet, HV-4, also includes a graph comparing the absorption rate of Hevimet and lead under a narrow beam of cobalt 60, in addition to detailed mechanical, thermal, electrical and other property evaluations.

Rubber Engineering

Plastic and Rubber Products Co. of 2100 Hyde Park Blvd., Los Angeles 47, Calif. and Parco Rubber Products Co. of Houston, Tex., announce a new informative pictorial brochure, No. 1090, "Customized Rubber Engineering", describing the types of materials, methods, measurements and specifications used by Plastic and Rubber Products and their new Houston plant in regard to hydraulic sealing problems.

Microprint Reader

Eastman Kodak Company has published a folder illustrating and describing its new Kodagraph microprint reader, a device designed to be used in offices and libraries where literature and reference books have been reduced to microprint cards.

The folder notes that as many as 60 standard book pages may be reproduced photographically in miniature on one side of a standard 3 × 5 in. library catalog size microprint card, or larger. Illustrated in full color, the new folder points out features of the reader which the company says it is now manufacturing in quantities to make the microprint idea a practical reality.

Remote Indication

Evershey & Vignoles, Ltd., Acton Lane Works, Chiswick, London W.4., has issued a 28-page bulletin on remote indication and centralized control. Illustrations and diagrams outline the use of instruments in this field in waterworks, docks and harbors, sewage and drainage, sewage disposal, steel works, oil refineries, power plants, and gas works.

Roller Bearings

Hyatt Bearings Div., General Motors Corp., Harrison, N. J., has issued catalog 150, containing dimensions, load ratings and application data on the company's solid roller bearings, solid race bearings, split race bearings, industrial inch bearings.

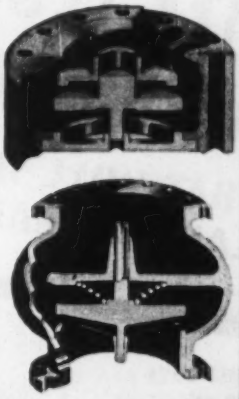
The 68-page catalog contains tables of engineering and dimension data, diagrams and photographs of the various types of bearings.

Engine Couplings

Two new data sheets, FS41–54, describing Morflex industrial engine flywheel flexible coupling units are now available from Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

These sheets illustrate and list specifications for standard units that will fit eight models of Chrysler industrial engines and twenty-nine models of Ford industrial engines. The units include a long-life, torsionally flexible, shock-resistant, weatherproof standard Morflex coupling and a balanced cast iron adapter plate that bolts to the engine flywheel through the clutch bolt circle holes. The units are sold with the adapter plate drilled to suit the particular engine model and no drilling or machining is required by the customer.

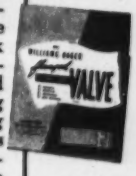
For all Piping systems handling...



WATER
OIL
GAS
ACIDS
ALKALIES
and other fluids

WILLIAMS-HAGER
FLANGED
Silent
CHECK VALVES

Send coupon today for your copy of Bulletin 654! This bulletin gives complete details on these dependable Williams-Hager check valves and how they eliminate water hammer and other costly and annoying noises in all types of piping systems. Available in sizes for every service. Renewable working parts. Write today.



THE WILLIAMS GAUGE CO., INC. 1254 ME
3013 Pennsylvania Avenue
Pittsburgh 33, Pa.

Please send me a copy of Bulletin 654 on Williams-Hager Flanged Silent Check Valves.

NAME
TITLE
COMPANY
ADDRESS
CITY ZONE STATE

THE WILLIAMS GAUGE CO., INC.
3013 Pennsylvania Ave., Pittsburgh 33, Pa.

FREE TECHNICAL PAPERS & ARTICLES

THAT WILL IMPROVE YOUR PLANT OPERATING EFFICIENCY

NEWLY PUBLISHED DATA BY PEERLESS PUMP ENGINEERS NOW AVAILABLE IN CONVENIENT FILE SIZE FORM

Illustrated are republished articles, authored by Peerless Pump engineering personnel, which were printed in leading trade journals. They contain a wealth of authentic, useful, practical, illustrative and descriptive information on pumps and allied subjects that you can use in buying or applying pumps. The articles shown are available individually or together. Request the articles you want. They will be mailed free from Peerless Pumps—manufacturers of one of the broadest lines of horizontal and vertical pump lines for industrial and commercial application.

WHAT IS NPSH
By D. R. Rankin, Ch. Eng.
A widely used term completely described
FIRE PUMP APPLICATION
By W. J. Blair, Sls. Eng.
Useful Application Data
HORIZONTAL VS. VERTICAL PUMPS
By Melvin Mann, Ch. Prop. Eng.
An engineering analysis
CALCULATION & USE OF SYSTEM HEAD CURVES
By Melvin Mann, Ch. Prop. Eng.
For all types of layouts
PROPERLY PROPORTIONED SUMPS
By R. H. Bird, Designer
Complete with diagrams

MAIL THIS COUPON FOR BULLETINS YOU WANT

PEERLESS PUMP DIVISION

FOOD MACHINERY AND CHEMICAL CORPORATION
301 W. Ave. 26, Los Angeles 31, California

Please send reprints checked below:

☐ Fire Pump Application ☐ Horizontal vs Vertical Pumps
☐ What Is NPSH ☐ Sump Designs ☐ System Head Curves

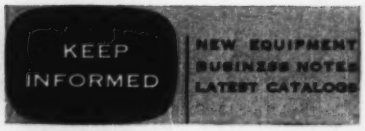
Name_____

Company_____

Address_____

City_____ State_____

ME



Plastisol Coatings

Data on application technique for low-cost plastisol coatings on wire goods, paper, fabric, foil and electrical assemblies are made available in a new 36-page booklet on Bakelite vinyl dispersion resin QYNV. The new booklet also describes compounding and production of plastisols based on this resin as well as its general properties. Copies of the booklet, "Bakelite Vinyl Dispersion Resin QYNV, Technical Release No. 14", can be obtained from Bakelite Co., a division of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N. Y.

Worms, Worm Gears

Boston Gear Works, Quincy 71, Mass., has announced the availability of its textbook on worms and worm gears, the third in the company's engineering textbook series.

The 114-page book covers the basic principles and applications of worms and worm gears and is illustrated with diagrams. Everyday practical gear problems are presented along with methods for solving them. Material is presented slowly, step by step, to avoid confusing the student, and each section is summarized. Cost of the book is $3.25.

Power Piping

Blaw-Knox Co., Power Piping and Sprinkler Div., Pittsburgh, Pa., has issued bulletin 2443, an eight-page booklet of illustrations of power piping. The booklet also contains information on the use of functional spring hangers and piping suspension.

Electronic Fan Bulletin

The extended line of Axivane fans for aviation and electronic applications is described in a new bulletin, J-614, announced by Joy Mfg. Co., Oliver Bldg. Pittsburgh 22, Pa. A summary of the features qualifying the units for these applications is included with specifications for the 80 standard models.

The company says vaneaxial design, with aluminum and magnesium construction, results in lightweight, sturdy, compact, powerful units for a variety of duties requiring efficient circulation of hot or cold air in aircraft, and specialized complex applications involving airborne or ground located electronic equipment.

Temperature Controller

Descriptive literature on what is called the first indicating temperature controller to utilize a thermistor as the sensing element, is now available from the manufacturer, Fenwal Inc., Ashland, Mass.

In addition to listing complete performance specifications of the unit, Series 560, the brochure also covers the unique design features accruing from the use of the thermistor. Features include selective control (either on-off or proportional), a response differential adjustable down to 0.25 per cent of scale (scale range 200 to 600 F), unusual mechanical and electrical stability plus simplicity of operation and maintenance.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Precision Cams

A four-page, two-color bulletin illustrating and describing a wide variety of types and sizes of cams for practically any kind of application has been announced as available by Ford Instrument Co. The bulletin lists cams in two major groupings: "3-dimensional" (two inputs) and single-input cams.

Information on construction and applications, and data on sizes, tolerances and materials are provided. A section is devoted to this firm's cam production facilities and design service. The bulletin is available from Ford Instrument Co., Div. of the Sperry Corp., 31-10 Thomson Ave., Long Island City 1, N.Y.

Teflon Gaskets, Accessories

United States Gasket Co., Camden 1, N.J., has announced an eight-page brochure which includes several types of Teflon jacketed, chemically-impervious gaskets, including special designs for metal, Haveg, Karbate, glass-lined, Pyrex and porcelain connections. Also listed are Teflon-jacketed adaptors for connecting nozzles of unlike sizes and materials, and Teflon expansion joints and flexible couplings.

Printed Circuits

Photocircuits Corp., Glen Cove, N. Y., has issued a bulletin outlining information on printed circuit boards, printed circuit subassemblies, and the company's design engineering service. The company lists as benefits of the printed circuits lower wiring costs, reduced assembly time, circuit reproducibility, improved reliability, miniaturization and product improvement.

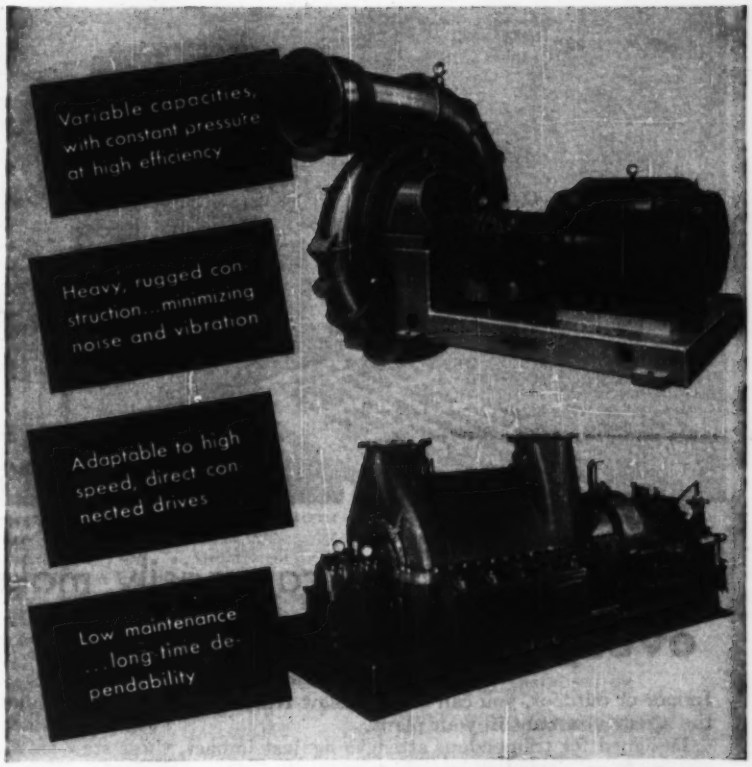
Electronic Data Systems

Literature describing the company's electronic data processing systems and their uses for purely scientific purposes to modern commercial applications in business and industry are now available from Remington Rand Inc., 315 Fourth Ave., New York 10, N. Y.

The various booklets, pamphlets and reprints, describe how the company's electronic computer systems perform in record time and with guaranteed accuracy such jobs as statistical reports, engineering problems, scientific analyses, pricing and rate studies, forecasting, production planning, design studies, valuation studies, payrolls, general accounting, and other vital statistics and data.

Included in the material are detailed reports on "The Role of General Purpose Digital Computers in Automatic Control and Information," "Notes on the Logic of the Univac Scientific," "The Univac Tube Program," "Application of the Univac System to Invoicing."

Reprints include "Electronics Down to Earth," "GE and Univac: Harnessing the High-Speed Computer," "Life Insurance Gets the Univac," "They Met a Deadline," "Computing Material Requirements."


Variable capacities, with constant pressure at high efficiency
Heavy, rugged construction...minimizing noise and vibration
Adaptable to high speed, direct connected drives
Low maintenance ...long time dependability

LOOK FOR THE "BIG 4"

WHEN YOU BUY CENTRIFUGALS

Your specific needs may dictate other important characteristics in centrifugal blowers or exhausters. But even so, these four values are essential to over-all successful performance. You'll find them in every Roots-Connersville Centrifugal Unit, regardless of size. And if you desire variations to suit your application, the ability to meet these needs is a heritage of our 100 years' specializing in equipment to handle gas and air.

You'll find first-cost economies, too, in the wide range of capacities of R-C Centrifugals. From 2,000 cfm to 100,000 cfm, you can choose the single-stage or multi-stage unit most closely matched to your individual requirements. You can count on the same high quality of performance that has made many thousands of first-time buyers enthusiastic, repeat customers for R-C equipment.

For your present or future requirements, we suggest you call on Roots-Connersville, for 100 years the specialists in handling gas and air.

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.
1254 Michigan Ave. • Connersville, Indiana

BLOWER BUILDERS SINCE 1854

Specialists in handling gas and air

Stair treads by BLAW-KNOX

you can easily make

every step a safe step

Indoor or outdoor, you can rely on Blaw-Knox Stair Treads to provide the safety you want in your plant.

Designed for tremendous strength against impact, these stair treads are made with twisted cross bars and rolled diamond checkered plate nosing—as illustrated.

But, when desired, you can get treads with a twisted cross bar nosing or an abrasive nosing. And for specially slippery conditions we can supply you with serrated cross bar treads.

Just tell us what your application is and we'll offer our recommendations as to the best type of tread for your job.

Only Blaw-Knox Electroforged® Steel Grating and Stair Treads —have these five exclusive features:

1. rigid one-piece construction—easy to install
2. all surfaces accessible—easy to paint
3. no sharp corners to clog—self-cleaning
4. maximum open area—for light and ventilation
5. non-slip twisted crossbar—safe footing

A short note will bring you a copy of new Bulletin No. 2365-R —a dimensional sketch will bring you a quotation.

BLAW-KNOX

BLAW-KNOX COMPANY
2105 Farmers Bank Building • Pittsburgh 22, Pa.

BLAW-KNOX EQUIPMENT DIVISION
GRATING DEPARTMENT

GRATING APPLICATIONS: floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating.

Alloys Bulletin

General information and technical data on vacuum-melted metals and alloys, as well as several commercial services now available in connection with such metals, are included in a new technical bulletin issued by Carboloy Dept. of General Electric Co., Detroit 32, Mich.

The publication, referred to as technical bulletin VM-100, covers the department's background and experience and that of the company's research laboratory in producing these special alloys, new alloys now available, and their physical properties.

Processing Equipment

Badger Mfg. Co., Cambridge 41, Mass., has released a comprehensive bulletin outlining its broad services in the fields of design and construction of process plants and process units; design and/or fabrication of special processing equipment, including a variety of trays and boiling caps; corrugated type expansion joints, both directed flexing, self-equalizing and non-equalizing; and vapor compression stills for purifying water in production volumes.

Copper, Brass Information

Copper & Brass Research Assn., 420 Lexington Ave., New York 17, N. Y., is issuing a quarterly magazine to provide interesting and timely information about copper and copper-base alloy mill products and their role in industry, communication, transportation and building.

Oil Burners

Bulletin No. 107 on high velocity oil burners is now ready for general distribution. From Thermal Research and Engineering Corp., Conshohocken, Pa. It contains complete information including operating principles, applications, dimensions and output data. The company says the burners are well suited for use in furnaces, ovens and dryers, kilns and in numerous specialized applications such as ladle heating, skelp furnaces, pressurized air heaters, bell kilns and submerged combustion equipment.

Surface Condensers

Data and technical information on problems of power plant engineering are contained in a new 20-page booklet released by Allis-Chalmers on the proportioning of surface condensing equipment.

The booklet concerns itself with surface condensers, how they operate, their nomenclature and definitions. It describes factors entering into the proportioning and selection of surface condensers, provides formulae for use in calculating the performance of a given condenser, and carries a variety of curves and tables for quick reference. Also included in the booklet is information on the chemical composition of tubes and recommended surfaces and tube proportions. Copies are available on request from Allis-Chalmers Mfg. Co., 940 S. 70th Street, Milwaukee, Wis.

Crown Couplings Bulletin

The De Laval Steam Turbine Co., Trenton, N. J., has issued a new bulletin describing its line of crown couplings. Included is an illustration showing an exploded view of the coupling and a table containing data necessary to select the correct coupling for a given application. Prices are specified. Bulletin 2203 available on request to the company.

Steel Forgings

The Amforge Division of American Brake Shoe Co. offers a 16-page, 2-color brochure on steel forgings. In the forging business for over 50 years, this division operates plants in the West and Midwest for the production of drop, upset, and press forgings. Facilities, quality control, and case histories are emphasized in the new booklet. Write Amforge Div., 109 N. Wabash Ave., Chicago 2, Ill.

Rotating Equipment

Information regarding the principle and use of eddy-current adjustable speed equipment is described in a 16-page bulletin, GB-2, released by Dynamatic Div., Eaton Mfg. Co., Kenosha, Wis.

Included are Ajusto-Spede drives, liquid and air cooled couplings and brakes, Dynaspede stationary field couplings, absorption, motoring universal and variable frequency dynamometers, press drives and special units. Basic principles are detailed of eddy-current machinery, torque, heat and operating characteristics, cooling efficiency and control.

Cast Monel Described

A new technical booklet describing the engineering properties of cast Monel has just been issued by the Development and Research Div. of the International Nickel Co., Inc. 67 Wall St., New York 5, N. Y.

The booklet says cast Monel combines high strength with good ductility and corrosion resistance, and that the material has a tensile strength comparable to carbon steel to give good performance under conditions of abrasion and erosion. Like wrought Monel, cast Monel is a nickel-copper alloy containing about two-thirds nickel. The booklet is available without charge from the company.

Cooling Towers

The question, "How do cooling towers save you money?" is answered in a new catalog on flow-cold cooling towers, recently published by Acme Industries, Inc., Jackson, Mich.

Five models of the company's cooling towers with capacities ranging from 3 through 15 tons are illustrated and described in the new catalog. Advantages of heavy-duty, all-metal galvanized construction are detailed and complete dimensions are given. A clear, simple selection procedure is given to enable the user to pick the model of tower best suited to his purposes.

Temperature Control

Burling Instrument Co., 16 River Rd., Chatham, N. J., has issued Bulletin 104, the fourth in a new series describing its line of temperature controls.

This bulletin covers the Model D-1S, primarily used for controlling temperatures up to 1800 F, where a wide and easily adjustable range is required. The instrument described operates by the differential expansion of solids and uses no filled bulb. A snap-action switch, rated at 15 amp, 125-250 v, 60 cycles, is actuated by the tube expansion through a lever.

Valve Bulletin

A new 20-page bulletin describing many design advancements in its 600 and 880 series of hand and foot valves has been released by Ross Operating Valve Co., Department 3102, 120 East Golden Gate, Detroit 3, Mich. The bulletin, No. 303-B, describes the valves in detail together with installation data, parts lists and exploded views of the valves to show the assembly relationship between parts. Colored air flow diagrams are also provided.

Side Dump Stoker

Riley Stoker Corp., Worcester, Mass., has issued a six-page folder describing its side dump stokers with moving grates for high capacities. The units are powered either by hydraulic or steam drive. Engineering data is given and photographs and diagrams illustrate the equipment.

Threading Stainless Steel

A folder, published by the Tubular Products Div. of Babcock & Wilcox Co., contains information and helpful hints on hand threading stainless steel pipe and tubing. It discusses die stock, dies, speed, cutting oils and the assembly of threaded joints. The folder is intended to assist pipe fitters to obtain satisfactory results when threading stainless tubular products with hand tools on job sites or in provisional field shops away from machine threading facilities. It is available from the division's office at Beaver Falls, Pa.

Engine-Generator Sets

A new bulletin on Le Roi "Custom Built" engine-generator sets is now available. The 8-page promotional piece describes and illustrates seven engine models from 60 to 675 hp with generators capable of producing from 50 to 350 kw.

Engine-generator features outlined in the literature include alternate fuel systems which permit the use of natural gas, LPG, gasoline and gas-gasoline or sludge gas fuels; a choice of radiator, heat exchanger or city water cooling systems; electric, automatic or engine starting; mechanical, full hydraulic or semi-hydraulic governors; and oil pressure and water temperature safety switches. Copies may be obtained from Le Roi Div. of Westinghouse Air Brake Co., 1706 South 68th St., Milwaukee 14, Wis.

ENGINEERS

RESEARCH
DESIGN
DEVELOPMENT
FOR
LONG RANGE GUIDED MISSILE PROGRAM

Aeronautical, Electrical, Mechanical and Chemical Engineers, and Physicists needed in the following fields:

PRELIMINARY ANALYSIS AND DESIGN OF GUIDED MISSILES
PRELIMINARY ANALYSIS AND DESIGN OF PROPULSION SYSTEMS
STRESS & DYNAMIC ANALYSIS
COMBUSTION DEVICES
TURBINES & PUMPS
VALVES & REGULATORS
FIELD TEST ENGINEERING
INSTRUMENTATION ENGINEERING FOR PROPULSION TEST
LIQUID AND SOLID PROPELLANTS
AERODYNAMICS
AEROTHERMODYNAMICS
AIRCRAFT STRUCTURES AND VIBRATION
MISSILE POWER PLANT SYSTEMS
MISSILE ELECTRICAL SYSTEMS
MISSILE HANDLING EQUIPMENT
WEAPONS SYSTEMS ANALYSIS
FLIGHT TEST ENGINEERS
FLIGHT TEST INSTRUMENTATION

Openings exist at both Senior and Junior levels. Junior engineers will be accepted, without experience, for training in the above openings.

For additional information please send resume to:

Missile & Control Equipment Dept. A
Engineering Personnel
NORTH AMERICAN AVIATION, INC.
DOWNEY, CALIFORNIA
In the N.Y. area, please contact our representative, Mr. G. W. Benedict, 19 Rector St., Rm. 1609, N.Y. 6, N.Y.

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Coal, Ore Handling

Various types of equipment and structures for handling coal, ore and other bulk materials are described in a 32-page illustrated booklet, published by Dravo Corp. The booklet discusses mechanical, electrical and structural features of such equipment as ore and coal bridges, man trolley unloaders, rope-operated towers, replacement trolleys, hydraulic buffers and rail clamps.

Copies of the booklet, entitled Dravo Equipment for Handling Bulk Materials, may be obtained without charge by writing on business letterhead to Dravo Corp., Crane & Bridge Dept., Neville Island, Pittsburgh 25, Pa.

Steel Castings Film

A 37-minute 16-mm full color sound film telling the story of steel castings by Lebanon Steel Foundry, Lebanon, Pa., is available on loan without charge upon request to Modern Talking Picture Service, Inc., 45 Rockefeller Plaza, New York 20, N. Y.

The film traces the various steps in making castings. Several animations illustrate what actually happens when intergranular corrosion takes place, and how it is overcome through proper heat treatment.

Tube Furnace Bulletin

Bulletin No. 310, describing high temperature electric tube furnaces for laboratories, has been announced by Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Two models and seven sizes of Burrell Unit-Package Tube Furnaces are listed. The furnaces are offered laboratory technicians for use in the determination of carbons-and-sulfurs-by-combustion in ferrous and nonferrous metals. The bulletin gives data on sizes, catalog numbers, dimensions, specifications, ordering data and prices. Separate charts list heating elements required.

Miniature Rigid Controls

Arens Controls, Inc., has produced a two-page illustrated bulletin on the use of its new miniature rigid push-pull controls. Among the uses for the controls described in this bulletin are manual reset operation of inaccessible controls, direct transmission of motion in compact mechanism, power transmission through confined areas and remote indication. Engineering drawings of these applications, as well as general specifications for the controls, are also given. Copies may be obtained by writing to Arens Controls, Inc., 2017 Greenleaf St., Evanston, Ill.

Bronze Bearings

More than 600 of the most widely used sizes (including standard sizes) of oil-retaining porous bronze bearings are listed by size in the new Stock List No. 4 issued by Bound Brook Oil-Less Bearing Co., Bound Brook, N. J. The list is based on the most popular stock sizes produced by the company since 1921 and has been prepared to save the user time by eliminating those bearing sizes which are infrequently used. In addition to listing the most popular sizes of flange, sleeve and thrust bearings, together with cored and solid bar stock, the list provides useful condensed information on application, installation, lubrication and machining.

Gear Set Selection

Selection and ordering information, worm dimensions, gear and spider standards, tool charts and horsepower ratings of standardized Cone-Drive gear sets are contained in 16-page Bulletin 700 available from Cone-Drive Gears Div., Michigan Tool Co., 7171 East McNichols Rd., Detroit 12, Mich. In addition to the standard center distances and reduction ratios available from stock, additional sizes available but not carried in stock are detailed in two pages of tables following the standard listings.

TO BE *Sure-*

ELLISON

PORTABLE LABORATORY TYPE INCLINED TUBE DRAFT GAGE

Ellison introduced the inclined tube draft gage in 1896. The portable laboratory type gage, shown above, combines all of the best features of our inclined tube gages. Monel frame. .2" oil depth. Level and tube replaceable in the field. Screw adjustment for zero setting. Clean out plug and needle valve drain.

Another dependable, highly accurate laboratory gage is the Ellison Inclined-Vertical Draft Gage, used for minus, plus or differential air pressures. A battery of four of these gages is shown at top left, in a testing laboratory set-up at Texas Western College, El Paso.

● *Ask for Bulletin 109A — tells the whole story of Laboratory Draft Gages.*

ELLISON DRAFT GAGE CO., INC.

552 WEST MONROE ST. SINCE 1896 CHICAGO 6, ILL.

The Ellison Line Also Includes:

Draft Gages, Ball and Diafram—Inclined Draft Gages—Portable Inclined Vertical Tube Gages—Vertical Tube Gages—Oil, Heavy Liquid and Mercury—Single and Multi-Tube-Saturator Gages— U Gages—Stationary and Portable—Air Filter Gages—Dial and Inclined Tube Types — Pitot Tubes — U Path Steam Calorimeters — Portable Gas Analyzers-Orsat Type

For fast . . . CLEAR-CUT MARKING of ROUND PARTS or TUBING in various diameters

MODEL GRD-950-1 MARKING MACHINE

Mark collets, tubing and other round parts or products of various diameters, economically with this machine. Part is placed on mandrel and a quick turn of the lever rolls marking into metal neatly and legibly. Investigate today!

Write for Complete Data!

Mecco SAFETY MARKING TOOLS

M.E.CUNNINGHAM CO.

1473 N. AVENUE, PITTSBURGH 33, PA.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Automatic Regulators

A four-page bulletin issued by the Atlas Valve Co., 280 South St., Newark, N. J., contains illustrations and descriptive paragraphs on 12 basic control valve types frequently used by the marine and chemical process industries, power generating facilities, and for numerous liquid or gas pressure control applications requiring precise instrumentation by means of automatic regulators.

Among the equipment described are two spring loaded, diaphragm operated and externally controlled steam reducing valves, two automatic valves for air, water or oil and a combination high pressure reducing and relief valve. Other basic types include a weight loaded, lever operated control valve for water, oil, gas or steam, an auxiliary operated float valve, a cam and lever control valve which is piston operated and internally actuated and two versatile spring loaded regulators for temperature and pressure control. Other devices pictured are for temperature control only, and a pneumatic thermostat for use with diaphragm control valves.

Magnetically Driven Centrifugal Pump

A magnetically driven centrifugal pump is described in a four-page bulletin available from The Fostoria Pressed Steel Corp. Called the Dynapump, this fractional-horse-power pump is driven by a rotating magnetic field instead of a drive shaft. The company claims that this type of pump makes possible a low-cost, leakproof unit that eliminates 90 per cent of the difficulties encountered with conventional pumps.

The motor and pump are in one sealed unit, and there is no shaft seal or stuffing box.

Standard units are stainless steel for pumping most fluids. The bulletin describes the characteristics, specifications, and performance of the Dynapump. It is available upon request from The Fostoria Pressed Steel Corp., Fostoria, Ohio.

Piloted Entrainment Burners

Eclipse Fuel Engineering Co., Rockford, Ill., has issued a bulletin covering their Piloted Entrainment Burners. Information concerning construction and specifications, including diagrams and charts, is furnished for the Series 16 PB and 20 PB Burners, and the Series 24 PBE Burner.

These Eclipse Piloted Entrainment Burners are said to be suitable for a variety of heavy-duty applications including forging, heat-treating, and boiler firing. Proportional mixing is incorporated as part of the assembly on these PB and PBE Burners, and is automatic over the entire range of the burner once the air/gas ratio adjusting valve has been set. It is only necessary to vary the air pressure; the gas quantity is varied automatically in the same relationship.

More information is contained in Bulletin H-64, from Eclipse Fuel Engineering Co., 1002 Buchanan St., Rockford, Ill.

Engineers!

Scientists!

UNLIMITED OPPORTUNITIES IN

Atomic Power

AT

Westinghouse

in a new plant on the outskirts of Pittsburgh, Pa. Atomic energy will be explored here as a source of power for transportation and industry.

Opportunities in this new field are unlimited for

MECHANICAL ENGINEERS

In design and development of nuclear reactors and components, rotating machinery, high pressure piping and fluid systems, heat transfer analyses, hydromechanical systems and mechanisms, stress analysis and machine design.

METALLURGISTS

To conduct basic research in physical metallurgy, corrosion and radiation effects on metals; applied research and development on materials and processes for reactor components in the fields of vacuum induction melting, powder metallurgy, welding, metal working and non-destructive inspection.

ELECTRICAL ENGINEERS

Design and development of electro-magnetic devices, control equipment and servo systems for pressure, temperature and flow; instrumentation and electrical and mechanical systems.

Openings also exist for Physicists, Chemists and Chemical Engineers.

•

United States citizenship is required.

Every fourth person now at the plant is an engineer or scientist, and over half of its executives are engineers.

Salaries open. Ample housing available. Benefits include a hospitalization-insurance program and graduate study under the WESTINGHOUSE program at company expense.

Send resume concerning your experience and education to:

Mr. C. F. Stewart, Atomic Power Division,
Westinghouse Electric Corporation,
P.O. Box 1468, Pittsburgh 30, Pa.

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Stainless Steel Piping

A bulletin outlining methods of bending and joining stainless pipe and discussing the problem of light wall versus heavy wall pipe has been issued by the tubular Products Div. of Babcock and Wilcox Co. Also included are a table of dimensions and weights of various stainless pipe size schedules and condensed technical data on mechanical and physical properties of the more popular stainless steels used for piping.

Copies of the bulletin, TB 356, are available free upon request to the division's general sales offices at Beaver Falls, Pa.

Power-Transmission Equipment

A new bulletin which covers American Pulley Co.'s complete line of power-transmission equipment is now available. There are brief descriptions of American's Wedgbelt drives, Shaft-King speed-reduction drives, adjustable-speed sheaves, steel split pulleys, conveyor pulleys, Econ-o-matic motor bases, individual cotton card drives, hi-torque pulleys, collars and shaft hangers. Illustrations accompany each description.

Copies are available upon request from the company, 4200 Wissahickon Ave., Philadelphia 29, Pa.

Hardsurfacing Alloys

Coast Metals, Inc., Little Ferry, N. J., has announced as available a four-page folder containing engineering data on the company's No. 18 alloy, supplied in the form of hardsurfacing weld rods, in cast form, or made to customer specifications. The material, primarily made for steam valve seat trim, has been used in other applications where wear resistance in the presence of heat combined with abrasion or impact, steam erosion or some types of corrosion is desired.

Resin Conversion Chart

A conversion chart for use with phenolic resins to cast industrial parts and consumer items is being made available by the Marblette Corp., 37-21 Thirtieth St., Long Island City 1, N.Y.

The guide utilizes the slide-rule principle to show at a glance the amounts of resin and accelerator required to produce a cast phenolic part of any size. Alongside a listing of Marblette phenolic casting resins, a table shows the percentage by weight of the appropriate hardener to be used with each. Another table covers applications. Information on physical properties and poundage of resin needed per cubic inch or cubic foot are included.

Transformer Connections

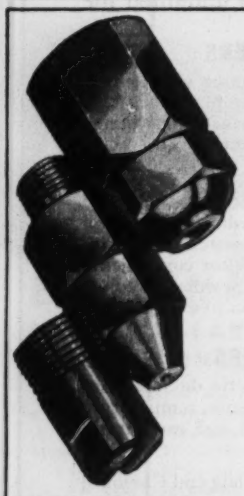
Solving network problems by tensor analysis is discussed in a new 16-page bulletin, "Tensors and Transformer Connections," released by Allis-Chalmers Mfg. Co. 940 S. 70th St., Milwaukee, Wis.

The first portion describes a method for eliminating magnetizing currents; the second section explains a method of using fictitious single-phase currents to determine transformer connections; the third tells how part one is used in tensor analysis to determine actual amperes flowing in the circuits.

Aluminum Alloy Chart

A handy wall chart showing the new designation system for wrought aluminum and wrought aluminum alloys has been prepared by Kaiser Aluminum & Chemical Sales, Inc., and is now available. The new four-digit system, developed by the Aluminum Association, became effective Oct. 1, 1954.

The guide indicates old and new designations in easy-to-read bold type and has been designed as a permanent reference. It may be used either as a wall chart, or punched and inserted in a three-ring binder for filing. It may be obtained from the company, 1924 Broadway, Oakland 12, Calif.



to whom it may concern:

If you'd like to try another and new approach to improving production where spraying is involved... may we suggest you consider* Spraying Systems Co.

SPRAY NOZZLES

as a first step . . . WRITE for the incomparable reference Catalog No. 24

SPRAYING SYSTEMS CO.
3265 Randolph Street Bellwood, Illinois

Many thousand industrial and chemical companies who are now Spraying Systems customers, once did this and are very glad they did.

FOR Quality Performance from
WIRE FORMS
SPRINGS
METAL STAMPINGS
Rely on
DUDEK & BOCK
You get precision WIRE FORMS, Springs and Stampings that are easily assembled . . . that withstand stresses . . . perform under the most trying conditions. Rely on our free designing service. Our EXPERT ENGINEERS will produce designs that meet your exact needs—and save you MONEY!
SPEEDY DELIVERY
WRITE—WIRE or PHONE for Estimates and Delivery Dates
Valuable FREE Brochure
Phone:
HAymarket 1-1880
DUDEK & BOCK
SPRING MFG. CO.
2100 W. Fulton, Chicago 12, Illinois

Glass containers for every purpose are designed and manufactured by Owens-Illinois Glass Company—over 100 billion units made in last 25 years

More than 3,000 new designs per year

—without a "bottleneck" in drafting

In the Design Development Department of the Owens-Illinois Glass Company, Toledo, Ohio, no time is lost in tedious redrafting. A simple short cut involving the use of Kodagraph Autopositive Paper and Kodalith Film *gives customers fast service . . . saves dollars every day.* Chances are you can adapt this technique to your own routines.

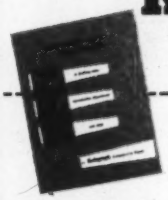
Big head start. Kodalith Film prints of elements which are repeated from time to time are kept on file. When a new design calls for any of these elements, the draftsman merely tapes the right films on clear acetate *and orders an Autopositive.* No redrafting!

A positive photographic intermediate is produced *directly* by exposing the "paste-up" in contact with Kodagraph Autopositive Paper, then processing the print in standard photographic solutions. No negative step . . . *easy room light operation.*

New design is added to the Autopositive, which has dense photographic black lines on a clean white translucent base. Required number of shop prints—each crisp and uniform—are produced from this master, which can also be used later on for minor revisions.

Kodagraph Autopositive Paper

"THE BIG NEW PLUS" in engineering drawing reproduction



Shows all the ways you can save with Kodagraph Autopositive Paper.

MAIL COUPON FOR FREE BOOKLET

16

EASTMAN KODAK COMPANY
Industrial Photographic Division, Rochester 4, N. Y.

Gentlemen: Please send me a copy of "New Short Cuts and Savings."

Name_____ Position_____

Company_____ Street_____

City_____ Zone____ State_____

Kodak

JENKINS PRACTICAL PIPING LAYOUTS

68

How to plan a

HIGH PRESSURE — HIGH TEMPERATURE HOT WATER PIPING SYSTEM

For many applications, a high pressure—high temperature system, like the one illustrated here, offers several distinct advantages over a steam system. It provides for efficient space heating and water heating, and also for numerous processing needs, such as dye vats, plating tanks and evaporators.

Often operated at pressures up to 215 psi, with a corresponding temperature of 388°F, a HP-HT system of this type employs a simpler piping design that eliminates the need for pitch, drainage, or traps. It provides a far greater amount of heat transmission for a given pipe size and, since makeup is extremely low, requires no feed-water treatment. Also, when this system is used for processing services, there are no large pressure drops due to sudden load conditions.

The hot water is generated in a shell and tube heat exchanger by means of high pressure steam from either turbine extraction or turbine exhaust. A closed expansion tank maintains constant pressure within the system. Water is circulated by regular closed expansion tank maintains constant pressure boiler feed type centrifugal pumps to all uses. A high pressure makeup pump delivers the small amount of makeup required. As shown in the diagram a recording and integrating Btu meter indicates thermal energy consumed by equipment.

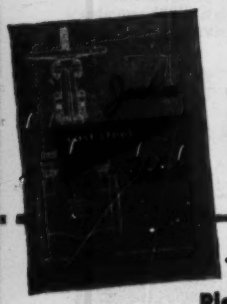
Unit heaters on the HP-HT lines provide for space heating requirements. A shell and tube heat exchanger supplies warm water for lavatories, kitchens, and processing which requires moderate temperatures.

When accumulators are used another important advantage of this system is the storage of steam in excess of the HP-HT demand. This feature is particularly desirable when the load on the turbine from which the steam is extracted or exhausted is not in coincidence with the system's demand. Under these circumstances, steam may be drawn from the accumulators to meet the increased HP-HT requirements. Thus, the need for taking additional steam directly from the steam generating source is decreased or eliminated, with a better plant heat balance as a direct result.

Jenkins Fig. 1010-CM Cast Steel Gate Valves are recommended for the thermostatic steam admission valve shutoffs in this system. For 300 lb. service, at temperatures to 850°F, they are made of carbon molybdenum alloy steel, with stainless steel wedges (up to 8" size) and H-monel seat rings. The rising spindle serves to indicate the position of the wedge. Operating threads are on the outside, allowing easy cleaning and lubrication.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installation.

To save time, to simplify planning, to get all the advantages of Jenkins specialized valve engineering experience, select all the valves you need from the complete Jenkins line. It's your best assurance of *lowest cost in the long run.* Jenkins Bros., 100 Park Ave., New York 17. Sold through Leading Industrial Distributors everywhere.



The *extra* measure of efficiency and endurance built into *all* Jenkins Valves is a distinguishing feature of Jenkins Cast Steel Valves. Compare the quality, and see why it pays to specify *Jenkins.* A new catalog of Cast Steel Valves gives detailed pressure ratings, dimensions, and other technical data covering all patterns. Send for your copy.

Jenkins Bros., 100 Park Avenue
New York 17, N. Y.
Please send folder Cast Steel Valves

Name.....

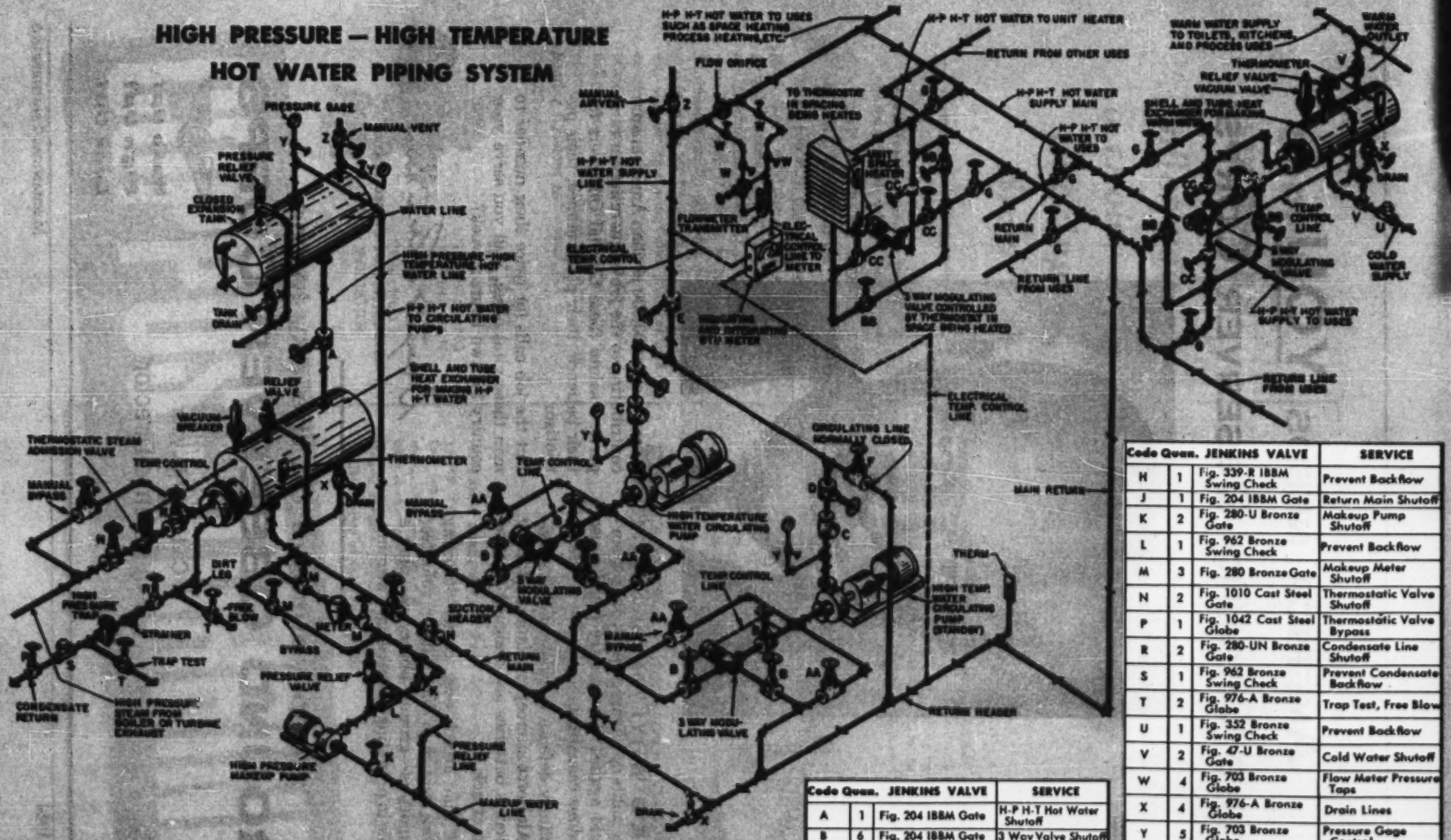
Company.....

Address.....

JENKINS
LOOK FOR THE DIAMOND MARK
VALVES
TRADE JENKINS MARK

Jenkins Bros

HIGH PRESSURE — HIGH TEMPERATURE HOT WATER PIPING SYSTEM



Code	Quan.	JENKINS VALVE	SERVICE
A	1	Fig. 204 IBBM Gate	H-P H-T Hot Water Shutoff
B	6	Fig. 204 IBBM Gate	3 Way Valve Shutoff
C	2	Fig. 339-R IBBM Swing Check	Prevent Backflow
D	2	Fig. 204 IBBM Gate	Pump Discharge Shutoff
E	1	Fig. 204 IBBM Gate	Supply Line Shutoff
F	1	Fig. 923 IBBM Globe	Circulating Line Shutoff
G	6	Fig. 280 Bronze Gate	Branch Shutoffs

Code	Quan.	JENKINS VALVE	SERVICE
H	1	Fig. 339-R IBBM Swing Check	Prevent Backflow
J	1	Fig. 204 IBBM Gate	Return Main Shutoff
K	2	Fig. 280-U Bronze Gate	Makeup Pump Shutoff
L	1	Fig. 962 Bronze Swing Check	Prevent Backflow
M	3	Fig. 280 Bronze Gate	Makeup Meter Shutoff
N	2	Fig. 1010 Cast Steel Gate	Thermostatic Valve Shutoff
P	1	Fig. 1042 Cast Steel Globe	Thermostatic Valve Bypass
R	2	Fig. 280-UN Bronze Gate	Condensate Line Shutoff
S	1	Fig. 962 Bronze Swing Check	Prevent Condensate Backflow
T	2	Fig. 976-A Bronze Globe	Trap Test, Free Blow
U	1	Fig. 352 Bronze Swing Check	Prevent Backflow
V	2	Fig. 47-U Bronze Gate	Cold Water Shutoff
W	4	Fig. 703 Bronze Globe	Flow Meter Pressure Taps
X	4	Fig. 976-A Bronze Globe	Drain Lines
Y	5	Fig. 703 Bronze Globe	Pressure Gage Control
Z	2	Fig. 976-A Bronze Globe	Air Vents
AA	4	Fig. 923 IBBM Globe	3 Way Valve Bypass
BB	4	Fig. 976-A Bronze Globe	3 Way Valve Bypass
CC	6	Fig. 280 Bronze Gate	3 Way Valve Shutoff

Diagram by Hunley Hackshaw, Consulting Engineer

COPYRIGHT, 1953 — JENKINS BROS.

For details of valves to suit varying conditions, see Jenkins Catalog.

AMERICA NEEDS YOU

IN THE GROUND OBSERVER CORPS!

© MURAY

HERE'S WHY: The potential of modern military offense is such that a surprise raid against this country could cause tremendous casualties.

Our military defense is aware of this possibility. Air Force interceptor planes and Army anti-aircraft batteries are designed to repel such an attack.

But—if that attack ever comes—*warning must come through in time!* Citizen volunteer plane-spotters—ground observers—play a vital role in providing the necessary warning.

Already some 300,000 civilian Americans are contributing to the job of guarding our ramparts. I salute these Ground Observers for their patience, their perseverance, their patriotism.

But the job calls for twice their number to man these vital posts. Will you serve your country for two hours a week?

Dwight D. Eisenhower

PRESIDENT OF THE UNITED STATES

★

Keep your eye on the sky in the

GROUND OBSERVER CORPS

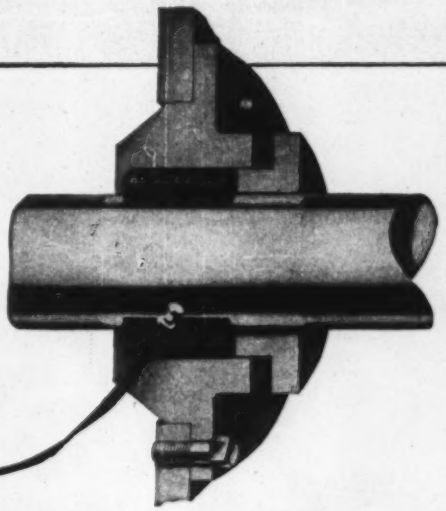
Call or write your

Civil Defense Director

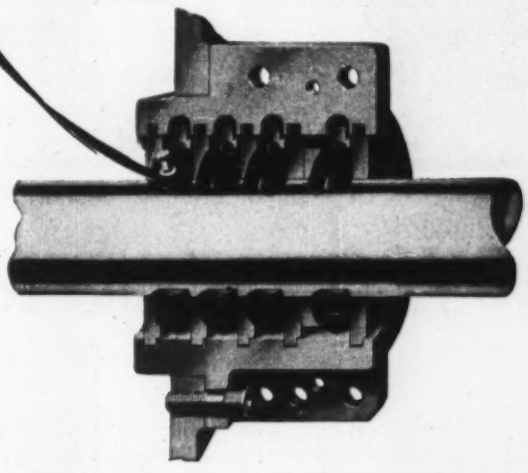
Wake Up!
Sign Up!
Look Up!

COPPUS TURBINES

offer you a choice of packing rings



STANDARD METALLIC RING PACKING — Made of high grade asbestos cores encased in specially treated lubricated aluminum foil. Recommended as a low-friction, long-service packing for steam temperatures up to 850 F and back pressures up to 50 lb. Adjustable packing glands keep leakage at minimum. Easy access to packing rings.



OPTIONAL CARBON RING PACKING — Consists of three carbon packing rings on the pressure side and one beyond the leak-off section. Each ring has three segments held together by a stainless steel garter spring. For back pressures up to 75 lb. Standard for vacuum or gas operation, or when leak-off is desired.

Heavy chrome plating on shaft at stuffing box is common to both types of Coppus packing.

Coppus Turbines ranging from 150 hp down to fractional in 6 frame sizes

FIT TURBINE COSTS TO HORSEPOWER NEEDS

When you buy turbines rated close to your exact horsepower needs, you save plenty of money. That's because turbines are generally priced in proportion to their size. The wide range of sizes of Coppus Turbines promises purchasing economy for you from the 150 hp size down to the smallest. As for operating and maintenance economies, you get them, too, from such other features as: greater number of manually operated valves for individual control of steam nozzles; replaceable cartridge-type bearing housings and others. For complete details . . .

WRITE FOR BULLETIN 135

COPPUS ENGINEERING CORPORATION
372 Park Avenue
Worcester 2, Mass.
Sales offices in THOMAS' REGISTER

COPPUS "BLUE RIBBON" TURBINES

Keyed...to your cost problems

One key that solves production and cost problems...that improves plant efficiency...is a fresh viewpoint, a new idea.

There's where the specialized services of your Chain Belt Field Sales Engineer can help you. His broad application knowledge...his familiarity with your problems...and the efficient performance of Chain Belt Products can help you find the right key to your problems.

for example: A lift truck manufacturer was seeking a way to reduce over-all costs. His CHAIN Belt Man suggested a change from standard roller chain to leaf chain. Result: lower cost and actually improved performance...far greater strength and life.

for example: A manufacturer of construction equipment was having field complaints about chain failure...with resultant excessive factory replacement costs. His CHAIN Belt Man suggested a change that solved the problem ...improved over-all performance.

for example: A conveyor manufacturer was trying to cut costs to achieve a more competitive price. His CHAIN Belt Man suggested a change from special roller chain attachment links to standard... reducing costs...with no loss of efficiency or life.

Often your CHAIN Belt Man can provide the "key" to your problems. Because he can offer all the advantages of a complete line of drive and conveyor chains, sprockets, attachments, roller bearings and couplings, he can recommend, without prejudice, the exact size and type that will help you cut costs. See him, or write Chain Belt Company, 4765 W. Greenfield Ave., Milwaukee 1, Wis.

CHAIN BELT COMPANY

District Sales Offices in all Principal Cities

50,000,000 Beam Candles

To Help Parker Design Fuel Nozzles for Jet Engines

Fuel nozzles for high-performance jet engines must be carefully designed for the desired range and magnitude of droplets in the fuel spray. The Parker Appliance Company, Cleveland, Ohio, has found photographic techniques made possible by the G-R Microflash® most satisfactory for this work. To quote Ned Shiflet, Manager of the Engine Accessories Division:

Photo courtesy Parker Appliance Company

"Flash bulbs of 1/80 second to 1/170 second light duration would not stop the high-velocity droplets in the atomized fuel spray. A commercially available high-speed electric flash with light durations as small as 1/30,000 second was also found unsatisfactory.

"Excellent photographs are now obtained using two synchronized Microflash units. These are located approximately 15 inches from the spray cone at 90°. Full size enlargements can easily be made and droplet sizes qualified. Photographs obtained are studied under a calibrated microscope, to determine actual droplet sizes."

Another Microflash® Application

Type 1530-A Microflash® $640.00

This is one more example of the value of ultra-high-speed photography made possible by the G-R Microflash. This instrument will stop objects moving as fast as 1,000 feet per second. It has been used for many diverse research and development jobs including investigations of projectiles in motion, pressure waves in gases, turbulence in liquids, and mechanical distortions at high rotational speeds.

The Microflash is portable, operates from a.c. lines and can be used with conventional camera equipment.

Flash Duration – 2 microseconds

Triggering – Pushbutton initiates flash – flash can also be triggered by sound or pressure wave produced by the action to be photographed; microphone and built-in amplifier are provided for this use.

Power Supply – 105-125 or 210-225 volts, 50-to-60 cycles.

Accessories Supplied – Microphone with cable, tripod, spare pilot lamp and fuses, 2 spare flash lamps, plug for contactor-trip jack.

Mounting – Power Supply and trigger circuits are in one metal case, the flash lamp in another. Both cases lock together for ease in transportation, and complete protection of lamp and controls.

Dimensions – 24¼ x 13¾ x 11⅞ inches. **Net Weight** – 72 pounds

We sell direct. Prices shown are NET, f.o.b. Cambridge or W. Concord, Mass.

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U.S.A.

90 West Street NEW YORK 6
8055 13th St., Silver Spring, Md. WASHINGTON, D.C.
920 S. Michigan Avenue CHICAGO 5
1000 N. Seward Street LOS ANGELES 38

ADMITTANCE METERS
AMPLIFIERS
COAXIAL ELEMENTS
DISTORTION METERS
FREQUENCY MEASURING APPARATUS
FREQUENCY STANDARDS
IMPEDANCE BRIDGES
LIGHT METERS
MEGOHMMETERS
MODULATION METERS
MOTOR CONTROLS
NULL DETECTORS
OSCILLATORS
PARTS & ACCESSORIES
POLARISCOPES
PRECISION CAPACITORS
PULSE GENERATORS
R-L-C DECADES
R-L-C STANDARDS
SIGNAL GENERATORS
SOUND & VIBRATION METERS
STROBOSCOPES
TV & BROADCAST MONITORS
U-H-F MEASURING EQUIPMENT
UNIT INSTRUMENTS
VARIACS®
V-T VOLTMETERS
WAVE ANALYZERS
WAVE FILTERS

Take these ASME publications for information....

Applied Mechanics Reviews

keeps engineers, scientists, and research workers abreast of progress in applied mechanics and related engineering science by providing critical appraisals of important new books and outstanding articles published in the technical magazines, special bulletins, and laboratory reports of 30 countries. Over 300 reviews, prepared and signed by recognized experts, are published monthly along with a survey of progress in a specialized phase of the field.

APPLIED MECHANICS REVIEWS Date.....

c/o ASME

29 W. 39 St., New York 18

You may send me APPLIED MECHANICS REVIEWS for one year beginning with the next issue. Payment will be made upon receipt of first number.

Name.....

Address.....

City.....Zone.....State.....

Annual subscription rates: $12.50 to non-members, $9.00 to ASME members. Additional postage outside U. S., Canada and Pan-American Union countries, 50¢.

Please check here.....if you are an ASME member.

Mechanical Engineering

is the acknowledged broad coverage magazine of the field. Its expertly written articles on broad significant subjects and on the latest in technical developments, its carefully prepared digests of ASME technical papers, its hundred of pithy items gathered from many sources combine to keep readers fully informed of major achievements throughout the mechanical engineering field.

MECHANICAL ENGINEERING Date.....

c/o ASME

29 W. 39 St., New York 18

You may send me MECHANICAL ENGINEERING for one year beginning with the next issue. Payment will be made upon receipt of first number.

Name.....

Address.....

City.....Zone.....State.....

Annual subscription rate: $7.00 in U. S., Canada and Pan-American Union countries, Elsewhere, $8.50

(For our records only—your business connection or position.....

Transactions of ASME

Designed for specialists, this monthly magazine provides a clearing house for authoritative information, data, experiences, and opinions of recognized experts in the fields of applied mechanics, fuels, gas turbine power, heat transfer, industrial instruments and regulators, management, metals engineering, process industries, power, production engineering, railroad, rubber, and plastics. Each issue contains approximately 15 technical articles supplemented by tabular data, valuable bibliographical material, and discussions.

ASME TRANSACTIONS Date.....

c/o ASME

29 W. 39 St., New York 18

You may send me the ASME TRANSACTIONS for one year beginning with the next issue. Payment will be made upon receipt of first number.

Name.....

Address.....

City.....Zone.....State.....

Annual subscription rates: $12.00 to non-members, $6.00 to ASME members in U. S., Canada and Pan-American Union countries. Elsewhere—$13.50 to non-members, $6.75 to members.

....on developments-in-the-making and the trends they portend.

FARREL RING GEAR

Twenty-foot boring mill table turned upside down to show the Farrel ring gear.

gives driving smoothness to boring mill table

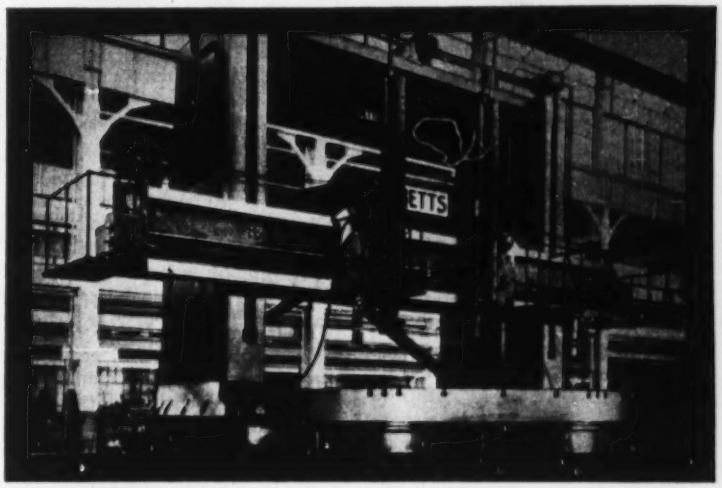
The huge single-helical ring gear built into this twenty-foot boring mill table is an important factor in obtaining an extremely fine finish on work turned on the mill.

Designed to impart driving smoothness to the table, both the gear and its mating pinion are precision generated by Farrel to a high degree of accuracy, and carefully fitted to eliminate the possibility of backlash. The pinion shaft is worm driven and this, together with the wide-angle helical gear, provides a smooth, chatter-free drive.

The gear, which is split, has a 30° right-hand helix angle, 276 teeth, 1½ DP. Its inside diameter is 183.294" and the face is 9¾" wide.

Farrel precision-generated internal gears are available with either helical or spur teeth in sizes up to 16 feet diameter, 12 inch face, ¾ DP. They are made of the finest grade materials.

Farrel engineers will be glad to assist you in working out unusual gear problems. Why not call on them?



The table is used on this Betts boring mill, made by Consolidated Machine Tool Corporation, Rochester, N. Y.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

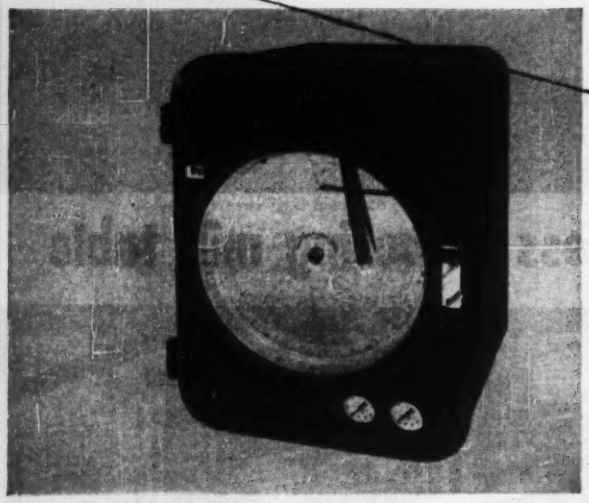
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Akron, Detroit, Chicago, Memphis, Minneapolis, Fayetteville (N. C.), Los Angeles, Salt Lake City, Tulsa, Houston, New Orleans

FB-940

Farrel-Birmingham ®

HAGAN

Ring Balance Meter *beats the high cost of* Permanent Pressure Loss!



It works out like this:

Using an Expensive Primary Element . . . 10% of 100″ full scale differential is *10″ PPL*

Using a Low Cost Primary Element . . . 50% of 6″ full scale differential is *only 3″ PPL*

The Hagan Ring Balance Meter is particularly adapted for accurate operation at full scale differentials as low as 1″ WC, with *any* type of primary element. In many applications, by choosing a low cost, low differential element, with a PPL of 50% or more, and measuring the flow with a Ring Balance Meter, the actual permanent pressure loss is low. In the example shown above, *it is only a third of the actual PPL* sustained with a high cost, high differential primary element. Here is positive, long range economy . . . lower pumping costs result from reduced horsepower requirement.

This is an example of how Hagan experience and engineering skill can reduce costs. Hagan engineers will be glad to recommend the most economical solution to your metering problem.

HAGAN HALL BUROMIN CALGON

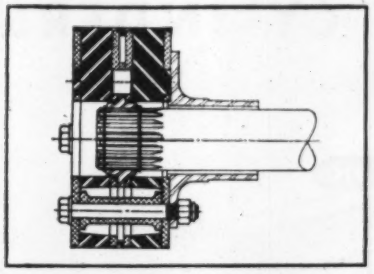
HAGAN CORPORATION

HAGAN BUILDING PITTSBURGH 30, PENNSYLVANIA

Boiler Combustion Control Systems, Ring Balance Flow and Pressure Instruments . . . Metallurgical Furnace Control Systems . . . Control Systems for Automotive and Aeronautical Testing Facilities

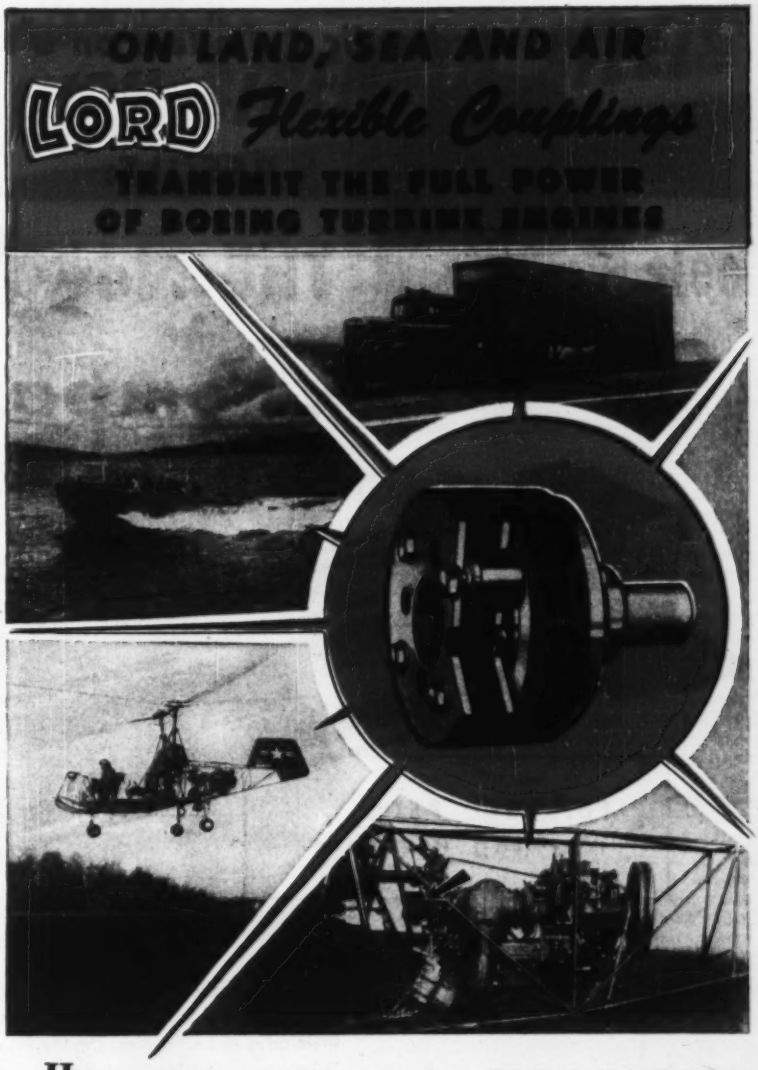
Lord Flexible Coupling Flies With Kaman Helicopter

The Kaman K-5 helicopter presents an interesting application of the LORD J-5329-2 flexible coupling with the Boeing 502-2 gas turbine. The function of the coupling in this case is to absorb the torsional vibrations of the system and isolate the turbine from the rotors. However, the unit also serves to accommodate angular or parallel misalignments due to manufacturing tolerances or dynamic motions.



The unique design of the installation provides maximum accessibility and economical maintenance through the use of concentric driving and driven shafts. The inner member of this pair is the engine shaft which drives the coupling hub through a splined connection. Precompressed against the splined hub are the two bonded rubber coupling halves which transmit the engine torque in shear of the rubber. Four through-bolts connect the outer plates of the coupling halves to the driven hub and also serve as the safety interlock in case the rubber sections are destroyed. The first gear of the transmission is mounted on this driven hub and feeds power on through the system in to the helicopter rotors.

For over thirty years the Lord organization has specialized in designing and producing Bonded Rubber Flexible Couplings, Vibration and Shock Control Mountings and Component Parts. The capabilities of Lord Engineering have proved their worth to designers of industrial and automotive equipment in many diversified fields as is indicated in this instance.



HERE again you see at a glance Lord versatility in designing bonded-rubber components for a wide diversity of machines. The photo at top right shows the Boeing Gas Turbine-Driven Truck-Trailer for heavy cargo hauling. At the top left you see a United States Navy personnel boat driven by the Boeing Gas Turbine Engine. Directly beneath is the Kaman Helicopter powered by the Boeing Gas Turbine Engine; details are clear in the foreground. The Lord Bonded-Rubber Flexible Coupling designed for the job transmits the power in each machine.

Special requirements like these reach satisfactory and economical solutions at Lord, Headquarters for Vibration Control. We invite you to take advantage of more than a quarter century of design experience and craftsmanship.

DETROIT 2, MICHIGAN 311 Curtis Building
LOS ANGELES 28, CALIFORNIA 7046 Hollywood Blvd.
CHICAGO 11, ILLINOIS 520 N. Michigan Ave.
CLEVELAND 15, OHIO 811 Hanna Building
PHILADELPHIA 7, PENNSYLVANIA 725 Widener Building
NEW YORK 20, NEW YORK 630 Fifth Avenue Rockefeller Center
DALLAS, TEXAS 313 Fidelity Union Life Building
DAYTON 2, OHIO 410 West First Street

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER

Headquarters for VIBRATION CONTROL

We put Hydraulic Cylinders on a reducing diet

RESULT:

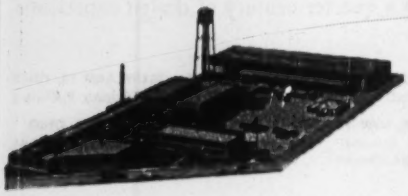
The New VICKERS® "Compact" HYDRAULIC CYLINDERS

For 2000 PSI Working Pressure

Everybody agreed that hydraulic cylinders were just too fat . . . took up too much space. So our engineers put them on a reducing diet. The result . . . these slim, powerful, "Compact" cylinders fit and work in spaces where the old type could not. It is part of Vickers long-time program of continuous improvement.

Among their many other features are: Multiple port positions. Spring-loaded synthetic-impregnated leather rod seal compensates for wear, assures long service. Piston seals are improved cup type. Tie rods are high tensile alloy steel. Adjustable integral hydraulic cushions are available. Comply with JIC standards. Conservatively rated for maximum working pressure of 2,000 psi. For further information, see Bulletin 54-68.

Waterbury Tool Division of Vickers Incorporated where "Compact" Cylinders are manufactured.



Ask for New Bulletin 54-68

VICKERS Incorporated

DIVISION OF SPERRY CORPORATION

1500 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices:

ATLANTA • CHICAGO AREA (Brookfield) • CINCINNATI • CLEVELAND DETROIT • HOUSTON • LOS ANGELES AREA (El Segundo) • NEW YORK AREA (Summit, N. J.) • PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS • TULSA WASHINGTON • WORCESTER

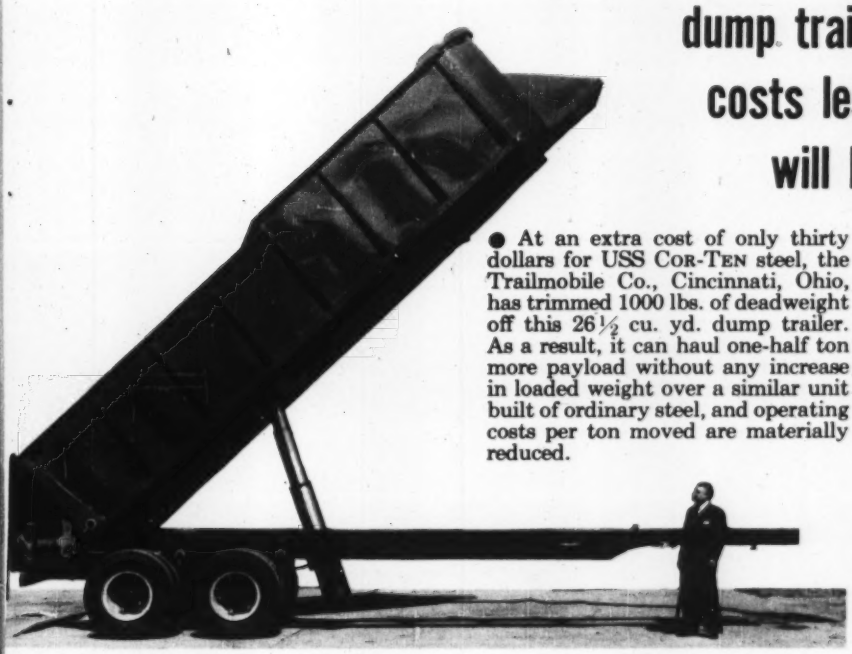
6950

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

New facts for your file on USS HIGH STRENGTH STEELS

Built 1000 lbs. lighter with USS COR-TEN steel

dump trailer hauls more, costs less to operate, will last longer



● At an extra cost of only thirty dollars for USS COR-TEN steel, the Trailmobile Co., Cincinnati, Ohio, has trimmed 1000 lbs. of deadweight off this 26½ cu. yd. dump trailer. As a result, it can haul one-half ton more payload without any increase in loaded weight over a similar unit built of ordinary steel, and operating costs per ton moved are materially reduced.

But USS COR-TEN steel does more than save weight and lower operating costs. Its high yield point of 50,000 psi—one and a half times that of carbon steel—gives the trailer body exceptional strength and toughness. Its much higher resistance to atmospheric corrosion, its superior resistance to abrasion, impact and wear greatly increase durability, keep the trailer on the job and help to prolong its life.

Since its introduction twenty years ago, USS COR-TEN steel has been used by 27 leading builders of trucks and trailers—names famous in the commercial car industry—to produce equipment that is lighter, more durable, able to do more work and cheaper to operate and maintain.

50% stronger and 20% lighter,

concrete forms of USS COR-TEN Steel last almost twice as long as carbon steel, materially reduce shipping costs

On many construction jobs, steel forms to hold concrete in place until it has hardened are now used instead of expensive wasteful forms built up of ordinary construction materials.

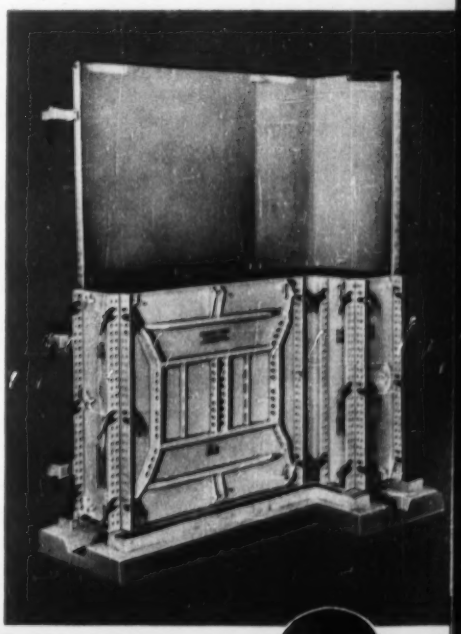
Such steel forms not only speed up work and save labor costs but, because they can be used over and over, save material as well.

A major producer of steel concrete forms is the Economy Forms Corporation, Des Moines, Iowa, which rents forms to contractors. This manufacturer reports that COR-TEN Steel used in their forms since 1948 has effected substantial savings because of its greater strength and higher corrosion resistance as compared to carbon steel.

For example, carbon steel forms, 30" x 30", can withstand a pressure of 1000 lbs. per sq. foot. They weigh 48 lbs. each and last about 6 years. In contrast, COR-TEN Steel forms of the same size, can withstand a pressure of 1,500 lbs. per sq. foot, but they weigh only 38 lbs. each and have a probable life of 8 years. The use of COR-TEN sheets for these forms has reduced the maintenance cost approximately 40%.

Concrete forms are shipped an average of ten times each year and here COR-TEN Steel forms pay further dividends because they weigh less.

Economy Forms Corporation estimates their freight savings to be 10¢ to 12¢ per sq. ft. per year, which runs into a pretty penny when you consider that they have 1,200,000 sq. ft. of forms in use.



USS

UNITED STATES STEEL COMPANY, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS

UNITED STATES STEEL

New facts for your file on

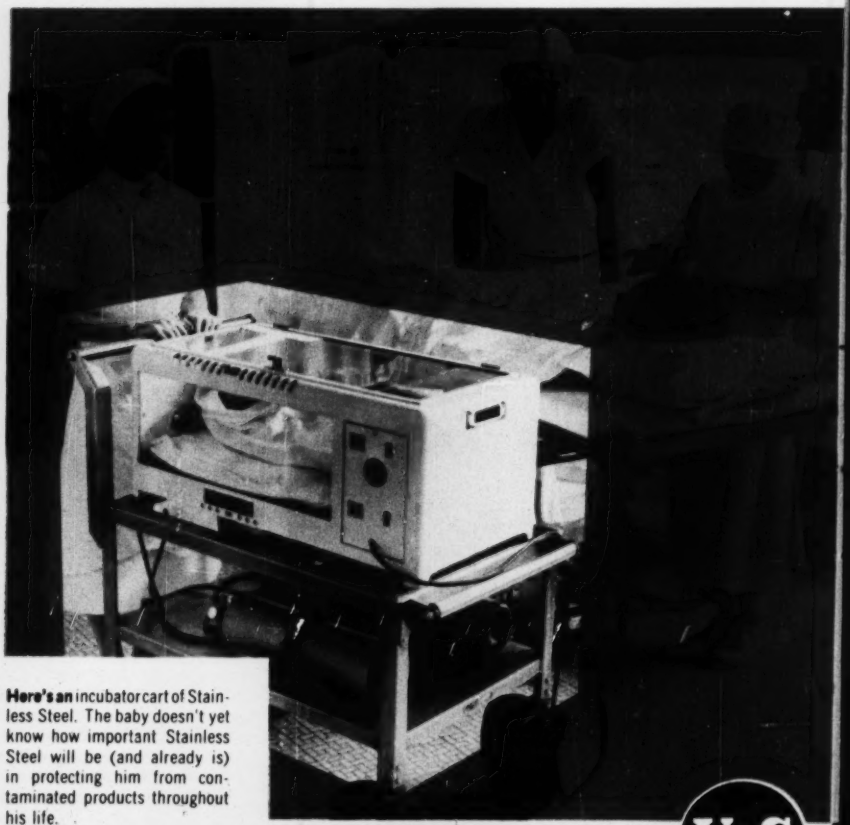
Hospitals depend upon Stainless Steel in kitchens and operating rooms...

This open-tray truck is also of Stainless Steel. So it will last longer and will be easy to keep clean and good-looking.

Another shining example of Stainless Steel beauty, this battery of food conveyor trucks will see many years of trouble-free service in the Cook County Hospital kitchen.

it's so easy to keep clean and sanitary

Stainless Steel equipment is vital to the operation of all modern hospitals. The Cook County Hospital in Chicago uses Stainless Steel extensively wherever equipment must be kept clean and sanitary. Only Stainless Steel is so dependably safe and so long lasting. It effectively resists rust and corrosion, is easy to keep clean and shining. All the Stainless products shown here are supplied by Colson Corporation of Elyria, Ohio.

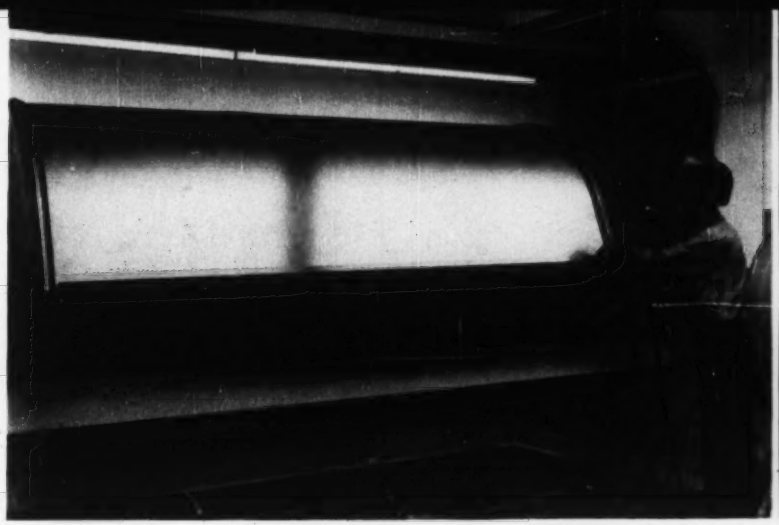


Here's an incubator cart of Stainless Steel. The baby doesn't yet know how important Stainless Steel will be (and already is) in protecting him from contaminated products throughout his life.

USS

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS



Here's the jig that holds the body sheets while the end sheets are arc welded on.

Frank Ramacier, shop foreman, inspects the finished pasteurizer.

Stainless Steel requires good mechanics, a little care, and good equipment for fabricating

Frank Ramacier, Metal Shop Foreman at the Farwell Metal Fabricating Division of Farwell, Ozman and Kirk Co., St. Paul, has been handling Stainless Steel and other metals for over 20 years. Says he, "If a fellow's a good metal worker, it doesn't take much to teach him how to handle Stainless." He recommends, of course, care in handling and good equipment in good condition.

As an example, let's see exactly how Farwell goes about fabricating a big 500-gallon milk pasteurizer . . .

302 Stainless Steel is used; 18 gage end sheets and 20 gage body sheets.

SHEARING. Paper protection is applied to protect the finish prior to shearing the 49½" x 106" sheets to 49" x 105". A ⅜" capacity shear with blades kept very sharp is used to assure greatest accuracy.

ARC WELDING. Two body sheets are butt welded together to make one body sheet.

NOTCHING. Heavy-duty (60-ton) press is used for top accuracy; notches sheet corners.

FLANGING. Five passes on a 16 gage capacity flanger secure 1" flange on end sheets.

BRAKING. ⅜" capacity brake press is used—again a heavy machine is used to guarantee greater accuracy. Top edge of the end sheets and top edge of the body sheet are flanged to 90°.

ARC WELDING. (second) Welding of the end sheets to body sheet is done on a special jig (see cut) that makes the welding easier and faster. The body sheet is shaped in this jig and is held until the end sheets are welded to it. Top corners are welded together. An outlet is arc welded.

GRINDING. Smoothes and polishes the welds.

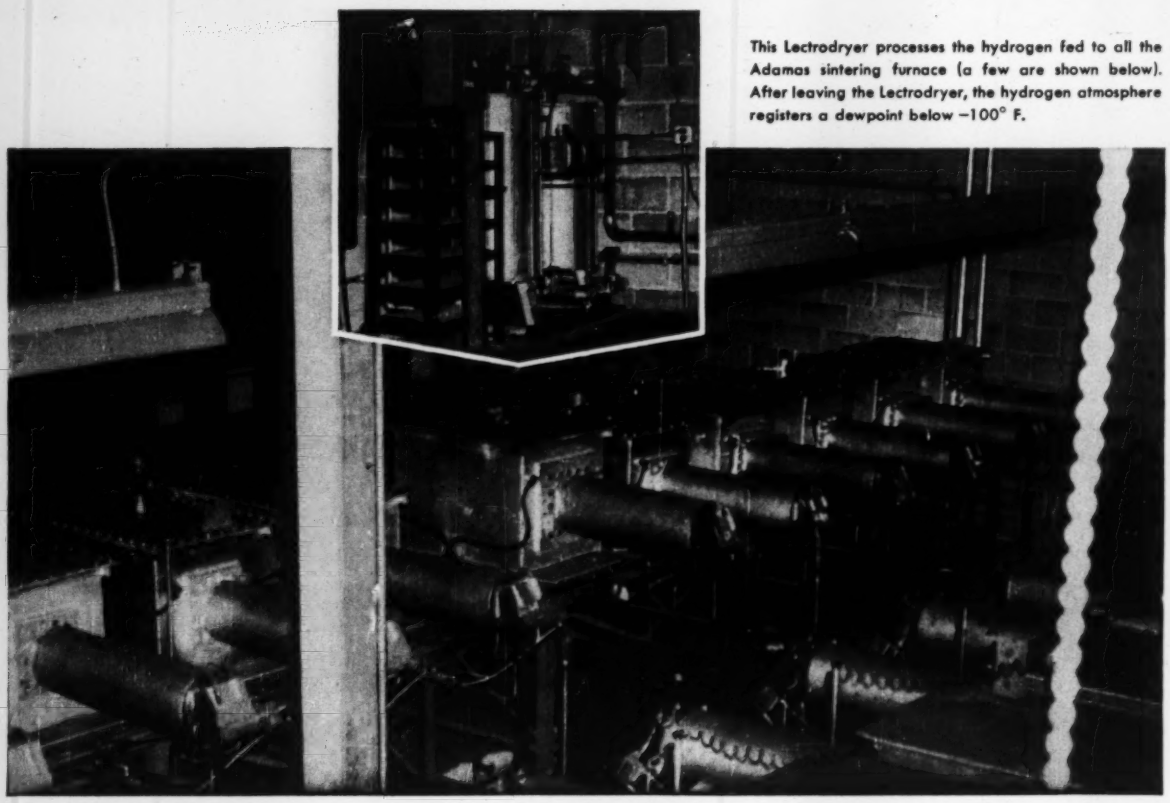
That's it and another non-contaminating, corrosion-resistant Stainless Steel pasteurizer is ready to go to work.

Take advantage of Stainless Steel in your designs and in your selling

Here are just a few examples of how Stainless Steel has been used to improve design, add sales appeal, give better end use results. The wide range of valuable properties available in Stainless Steel makes it the ideal material for many, many jobs.

Put Stainless to work for you. It will pay its own way and give you good return on your investment – especially if it is perfected, service-tested USS Stainless Steel.

USS Stainless Steel offers you the widest possible freedom in selecting the grade, shape and finish to fit your design and fabricating procedure best. And the services of our metallurgical engineers are always at your disposal to help you cut costs and get the best results from USS Stainless Steel.



This Lectrodryer processes the hydrogen fed to all the Adamas sintering furnace (a few are shown below). After leaving the Lectrodryer, the hydrogen atmosphere registers a dewpoint below −100° F.

Adamas Carbide insists on DRY hydrogen for sintering

A hydrogen dried to a dewpoint below −100° F prevents surface oxidizing of carbides being sintered at Adamas Carbide Corporation's ultramodern plant at Kenilworth, New Jersey.

To obtain such dryness, Adamas follows two steps:

(1) The hydrogen feeds through a catalytic cylinder which converts every trace of free oxygen into moisture.

(2) Then the hydrogen passes through a Lectrodryer* which snatches moisture from the gas, delivering it at a dewpoint somewhere below −100° F.

You can obtain similar dryness

Lectrodryers will economically remove unwanted moisture from air or other gases in a continuous, automatic cycle. For large or small volume—low or high pressures (to 6000 psi)—Lectrodryers of all types and sizes are available to solve your problem.

Talk it over with a Lectrodryer engineer. No obligation, and he may help you considerably. Write for the booklet, *Because Moisture Isn't Pink*, describing how industry is using Lectrodryers. Pittsburgh Lectrodryer Corporation, 335 32nd Street, Pittsburgh 30, Pa.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

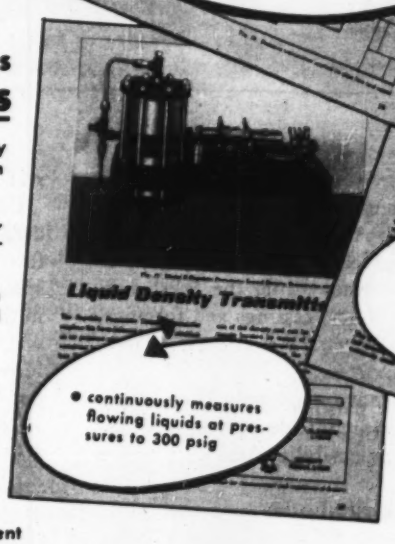
LECTRODRYER

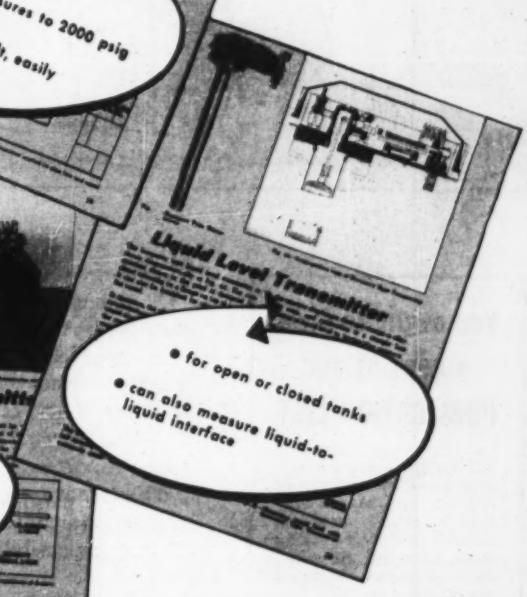
* REGISTERED TRADEMARK U.S. PAT. OFF.

Yours
For the Asking—

New DATA BOOK
about ALL
REPUBLIC
Pneumatic Transmitters
for Measuring
FLOW • PRESSURE
LEVEL • DENSITY

Differential Pressure Transmitters
• for flow and other differentials as small as 0-0.6" H20 and as large as 0-750 psi
• can handle most corrosive fluids





REPUBLIC
Pneumatic Transmitters
have these FEATURES

- ACCURACY to 1% and in many cases ½ of 1% of maximum range scale
- RANGE EASILY CHANGED, reversed, suppressed or compounded
- SENSITIVE because minimum movement is required for full scale change
- RUGGEDLY BUILT for long service life and overrange protection
- USES NO SEAL POTS, mercury or purge
- EXACT LEVELING NOT REQUIRED
- UNAFFECTED by vibration, ambient temperature variations and changes in line pressure, air supply pressure and fluid density

• SEND FOR DATA BOOK 1004 TODAY—NO OBLIGATION

REPUBLIC FLOW METERS CO.
2240 Diversey Parkway, Chicago 47, Illinois

You don't have to shop around... Allegheny Stainless is produced in every form you may need

You ought to have a copy of our PUBLICATION LIST

This 8-page bulletin lists and describes all the current publications on the principal families of A-L Products: stainless and heat-resisting steels, tool and die steels, electrical steels and alloys, permanent magnet materials, and Carmet carbides. There is a handy order form for your convenience in getting the material you need: technical and fabricating data, information on applications and fields of utility, etc. *Write for your copy.*

ADDRESS DEPT. ME-60

WHATEVER your stainless steel requirements may be, you can satisfy them with Allegheny Metal.

It's produced in any grade, form or finish you want—from the finest wire to heavy plates, castings and forgings, including sheets, strip, bars, shapes, tubes—*everything!*

That's not only handy, but advantageous: one reliable source, one undivided responsibility, one well-known standard of quality and uniformity.

Complete technical and fabricating data—engineering help, too—are yours for the asking. Just keep it in mind to specify "Allegheny Metal" when you're in the stainless market. And remember, wherever you use it, Allegheny Metal looks better, lasts longer, usually works out to be cheaper in the long run. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

You can make it BETTER with

Allegheny Metal

TIME-TESTED STAINLESS STEEL

Warehouse stocks carried by all Ryerson plants

W & D 4741

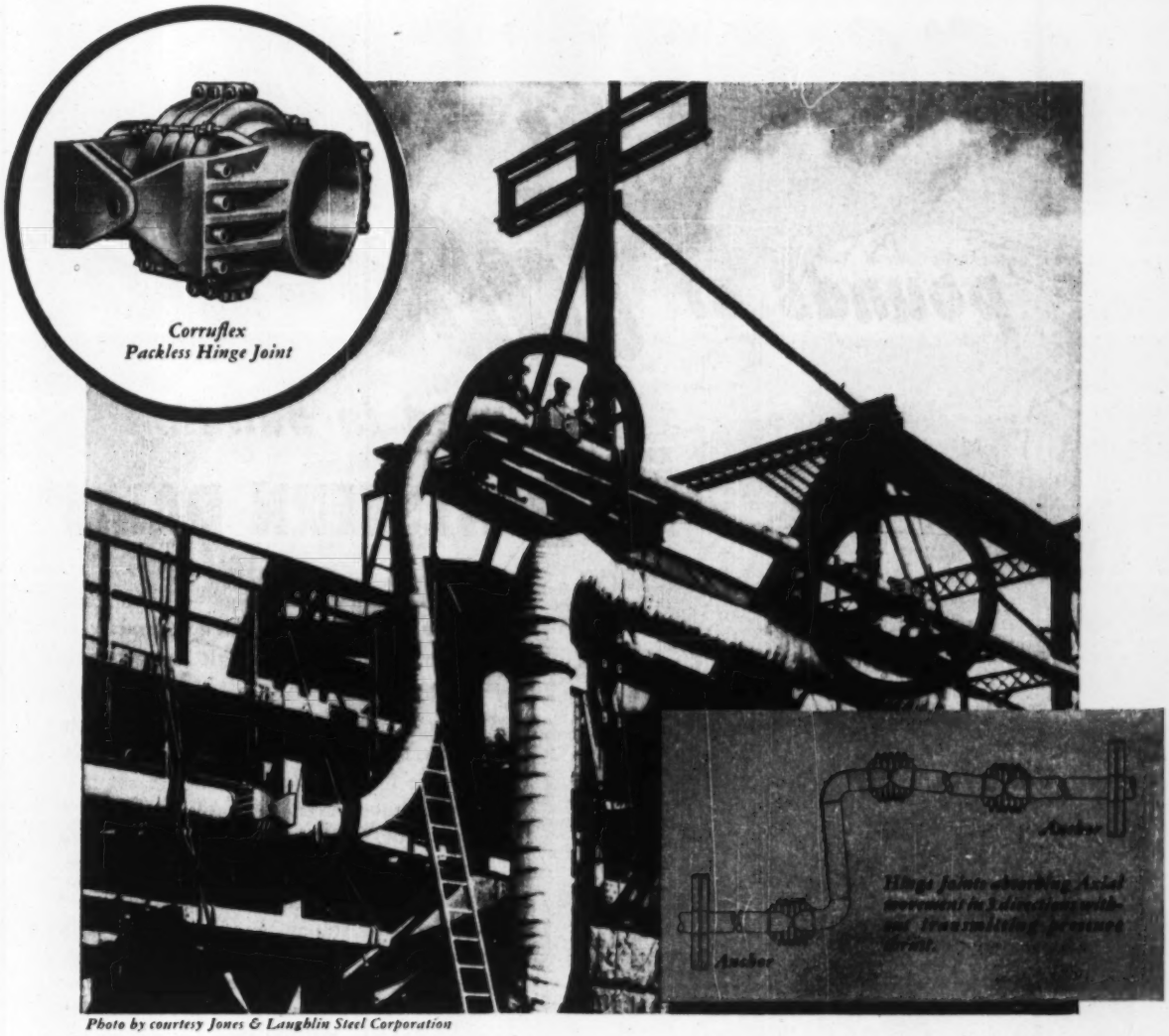


Photo by courtesy Jones & Laughlin Steel Corporation

HINGING A 14" STEAM LINE

● The Jones & Laughlin Steel Corp. in Pittsburgh last year had an excess of steam on one side of the Monongahela River and not enough on the other, where it was vitally needed. To correct this condition, J & L engineers planned to construct a high-pressure, superheated steam line along existing bridges and trestles to transmit the excess of steam to the other side.

However, a great difficulty soon appeared. If conventional expansion joints or loops were used at the 90° turns, pressure thrusts at anchor points would have been great enough to damage the bridges and trestles and actually cause these structures to collapse into the river.

Obviously, something else had to be used. With the aid of Adsco's Engineering Department, J & L "hinged" the pipe line with Corruflex Hinge Joints. These joints cannot develop pressure thrust because their two ends are held apart. They permit movement of a pipe line while keeping anchor loads at a minimum. When used properly, as pictured here, they will permit axial motion of one section of pipe line by permitting angular motion of another section.

Hinge Joints are only one type in the diversified Corruflex line of packless expansion joints. If you have a pipe expansion problem, consult Adsco. Making the world's most complete line of expansion joints, both slip and packless, Adsco will have the right answer.

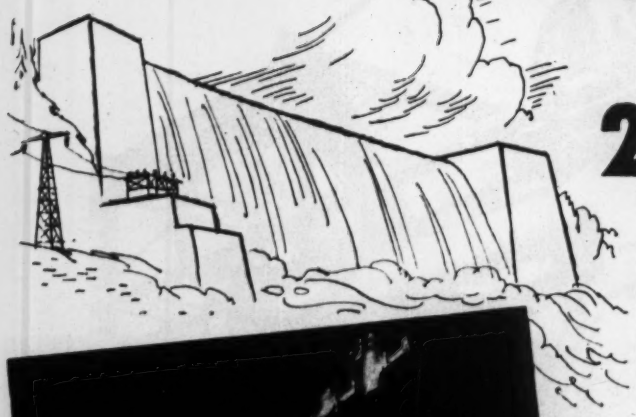
ADSCO
ENGINEERED
PRODUCTS

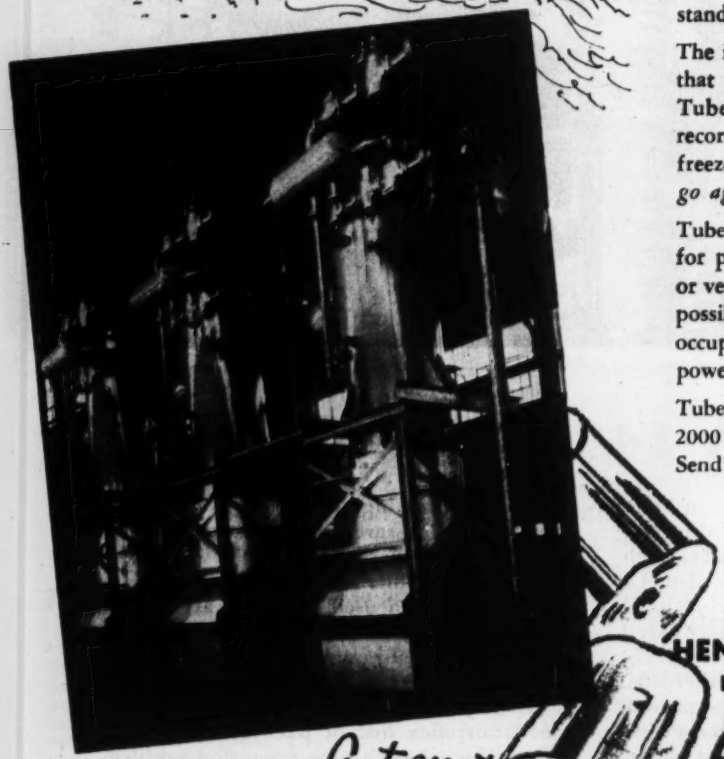
AMERICAN DISTRICT STEAM COMPANY, INC.

GENERAL OFFICES
NORTH TONAWANDA, NEW YORK

PLANTS
NORTH TONAWANDA, N. Y., AND RICHMOND, CALIF.

186,072,500 pounds of Tube-Ice used in building 2 WESTERN DAMS*





Yes—that much ice was required to cool the concrete mix in order that it set properly to develop its ultimate strength for two outstanding dam structures.

The important part of this message to you is that the compact and readily portable Vogt Tube-Ice Machines pictured here set this record without even the replacement of a freezer tube. What's more, they are *ready to go again* whenever ice is needed in quantity.

Tube-Ice is widely used in process work and for preserving shipments of meat, fish, milk or vegetables... and is produced at the lowest possible cost per ton since a Tube-Ice unit occupies less space, has fewer parts, uses less power than any other method for making ice.

Tube-Ice Machines are available in sizes from 2000 lbs. per day up to any desired capacity. Send for free Bulletin TI-3.

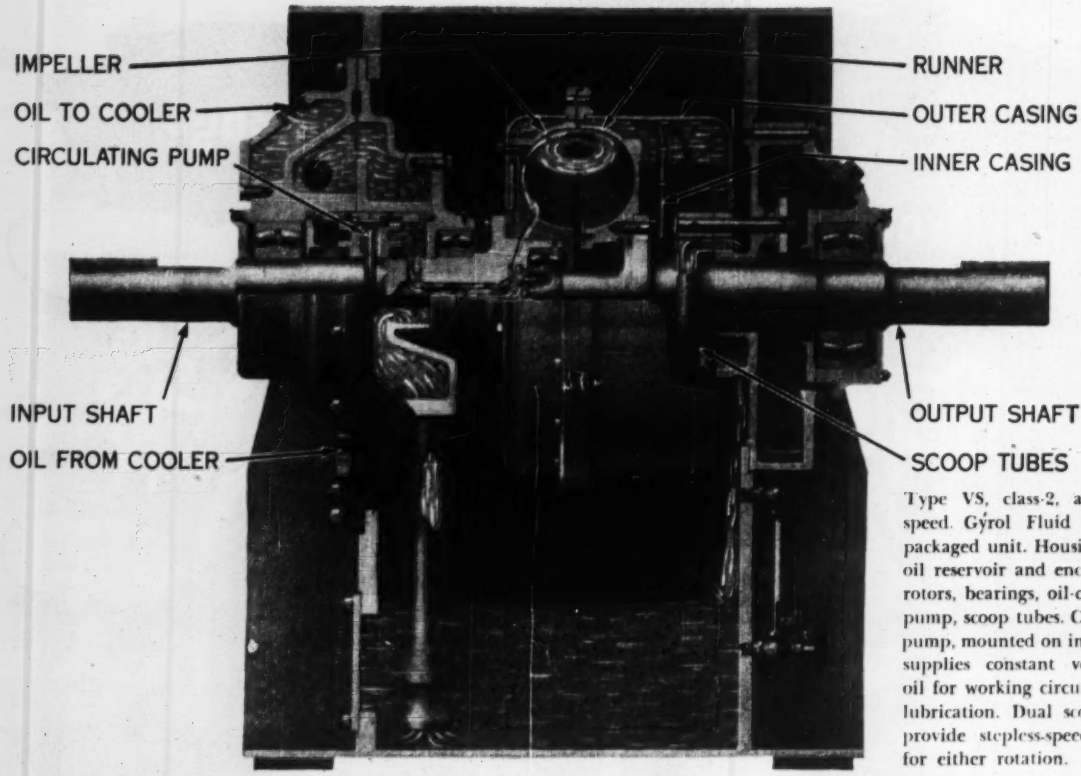
**McNary Dam, Washington, and Pine Flats Dam, California, required a total of 2,730,000 cu. yds. of ice cooled concrete mix.*

HENRY VOGT MACHINE CO.
LOUISVILLE 10, KENTUCKY
BRANCH OFFICES
...hio, Chicago, Cleveland,
...leston, W. Va.

Automat

Vogt TUBE-ICE MACHINE

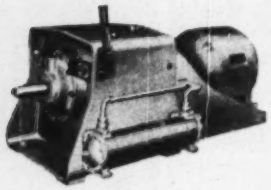
here is the means for
Fast, Trouble-free Condensate Drainage
THE ARMSTRONG "HIGH CAPACITY" DRAINAGE TRAPS
Big air vent for fast heat-up
Hardened chrome steel valve and seat—for long, long life
A size for every job.
Condensate and air enter above water level—preventing wear-producing agitation
BIG CAPACITY
Bucket and lever assembly are stainless steel to fight wear and corrosion
Add it up!
1. All the capacity you need
2. Fast air venting
3. Low Maintenance
Mail the coupon now!
Unconditional GUARANTEE
Satisfies you or your money back
ARMSTRONG
INVERTED BUCKET STEAM TRAPS
ARMSTRONG MACHINE WORKS
894 Maple Street, Three Rivers, Michigan
Send 44-page Steam Trap Book.
Name
Company
Street Address
City
State



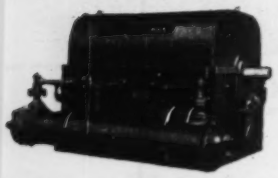
Type VS, class-2, adjustable-speed. Gyrol Fluid Drive — a packaged unit. Housing acts as oil reservoir and enclosure for rotors, bearings, oil-circulating pump, scoop tubes. Circulating pump, mounted on input shaft, supplies constant volume of oil for working circuit and for lubrication. Dual scoop tubes provide stepless-speed control for either rotation.

Choose the exact fluid drive you need!

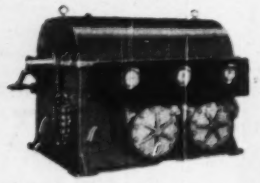
Type TM Gyrol Fluid Drive: motor, traction-type drive in a single unit; 1 to 20 hp; Bulletin 8519. Type T: traction-type less motor; ½ to 200 hp; Bulletin 7419.



Type VS, class-2, adjustable-speed Gyrol Fluid Drive. Speed range: 5 to 1. Six sizes, 7½ through 800 hp; speeds up to 1,800 rpm. Request Bulletins 9419 and 9519.



Type VS, class-4 Gyrol Fluid Drive — an adjustable-speed drive for fans, compressors and pumps, etc. 100 to 2,500 hp; speeds up to 1,800 rpm. Ask for Bulletin 9319.



Type VS, class-6 Gyrol Fluid Drive — adjustable speed drive for boiler-feed pumps, compressors, other high-speed applications. 400-12,000 hp; to 3,600 rpm. Bulletin 8019.

American Blower offers you a complete line of Gyrol Fluid Drives — including the new type VS, class-2, adjustable-speed model

Application possibilities are unlimited with American Blower's Gyrol Fluid Drive line!

For example, the new type VS, class-2, adjustable-speed Gyrol Fluid Drive can be reversed while in motion — at any adjustable operating speed — by merely changing the direction of rotation of the motor! And you can use this compact, self-contained unit in a variety of arrangements of the driving motor.

The standard Gyrol Fluid Drive line includes constant-speed and adjustable-speed units — up to 12,000 hp, and speeds to 3,600 rpm. You'll find there's a Gyrol Fluid Drive to fit practically any application.

For fact-packed bulletins and complete engineering data, get in touch with your nearest American Blower or Canadian Sirocco Branch Office; or write us direct. Do it, today!

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

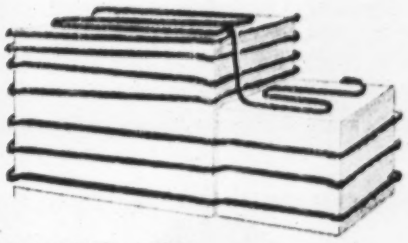
AMERICAN BLOWER

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*

SWEATER DRYING FORM

LEGS FOR MODERN DESK



COILS FOR HOME FREEZER

REMARKS Are complicated tubing snarls eating into profits? Why not let skilled Bundy engineers show you how to simplify fabrication operations; save time, money, materials. Why not check, too, the advantages of using strong, lightweight Bundyweld, the only tubing double-walled from a single metal strip.

WRITE today for catalog or for help in developing your tubing application.

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN

FRAME FOR TOY WHEELBARROW

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . .

continuously rolled twice around laterally into a tube of uniform thickness,

and passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

BUNDYWELD TUBING®
DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof	Lightweight
High thermal conductivity	Machines easily
High bursting point	Takes plastic coating
High endurance limit	Takes plating
Extra-strong	Bright and clean
Shock-resistant	No inside bead
Ductile	Uniform I.D., O.D.

Bundy Tubing Distributors and Representatives: *Bridgeport, Conn.:* Korhumel Steel & Aluminum Co., 117 E. Washington St. • *Cambridge 42, Mass.:* Austin-Hastings Co., Inc., 226 Binney St. *Chattanooga 2, Tenn.:* Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • *Chicago 32, Ill.:* Lapham-Hickey Co., 3333 W. 47th Place • *Elizabeth, New Jersey:* A. B. Murray Co., Inc., Post Office Box 476 • *Los Angeles 58, Calif.:* Tubesales, 5400 Alcoa Ave. • *Philadelphia 3, Penn.:* Rutan & Co., 1717 Sansom St. • *San Francisco 10, Calif.:* Pacific Metals Co., Ltd., 3100 19th St. • *Seattle 4, Wash.:* Eagle Metals Co., 4755 First Ave., South • *Toronto 5, Ontario, Canada:* Alloy Metal Sales, Ltd., 181 Fleet St., E.
Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.

the boy and the Star

He is old enough now to know that the ornament on the tree is more than simply a star . . . to understand the deeper meaning of Christmastime.

Now he knows that it is love that has been shining on the tree year after year, the love that has wrapped and held him . . . that has given him food and warmth and laughter and the promise of joy to come.

Life's great reward is the privilege of giving security to those we love—yet it is possible only in a country like ours.

And, think: When you make *your* home secure you are also helping make America secure. For the strength of America grows as the number of its secure homes increases.

Saving for security is easy! Read every word —now! If you've tried to save and failed, chances are it was because you didn't have a *plan*. Well, here's a savings system that really works — the Payroll Savings Plan for investing in U. S. Savings Bonds. This is all you do. Go to your company's pay office, choose the amount you want to save—a few dollars a payday, or as much as you wish. That money will be set aside for you before you even draw your pay. And automatically invested in Series "E" U. S. Savings Bonds which are turned over to you.

If you can save only $3.75 a week on the Plan, in 9 years and 8 months you will have $2,137.30. If you can save as much as $18.75 a week, 9 years and 8 months will bring you $10,700!

U. S. Series "E" Savings Bonds earn interest at an average of 3% per year, compounded semiannually, when held to maturity! And they can go on earning interest for as long as 19 years and 8 months if you wish.

If you want your interest as current income, ask your bank about 3% Series "H" Bonds which pay interest semiannually by Treasury check.

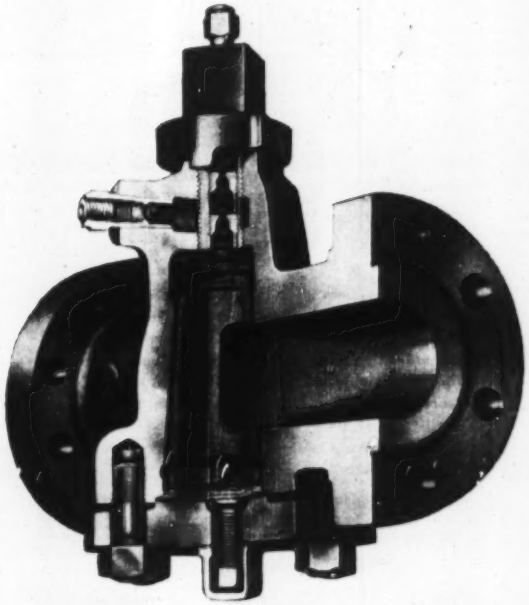
The U.S. Government does not pay for this advertisement. It is donated by this publication in cooperation with the Advertising Council and the Magazine Publishers of America.

What is the advantage of a lubricated valve?

Sometimes the purpose of lubricant in a valve is misunderstood.

The most important function of lubricant in a Nordstrom valve is to give a *tighter seal* than can be accomplished through any other method yet developed. The thin film of plastic lubricant that is forced around the ports of the plug is a *pressure seal* in itself.

Of course, the lubricant has other obvious advantages . . . the same advantages it has in your automobile, or in any other mechanical equipment where metal rubs metal. The lubricant all but eliminates the possibility of galling or seizing, and consequently keeps the valve ready to operate in a hurry. A lubricated Nordstrom valve operates easily even against high line pressures, because the plug turns *within* the line, rather than being forced or wedged *against* it. Since it takes only a quarter turn of the plug to open or close the valve, it operates in seconds instead of minutes.



Cutaway view of Nordstrom Hypreseal valve

HOW A NORDSTROM VALVE WORKS

In a Nordstrom valve, lubricant is forced through a series of grooves surrounding the plug ports. There it acts as an extra seal against the little leaks that become big problems. It is also forced into a lubricant chamber at the small end of the plug where it serves as a hydraulic jack to keep the plug easy to turn. Finally, it *lubricates* . . . that is, it prevents grinding wear, fills tiny imperfections that may develop, and it lets the plug slide without grating.

Don't be misled . . .

Valve lubrication doesn't *cost* money, it *saves* money. Your Nordstrom representative will help you select the right Nordstrom valves for your application. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

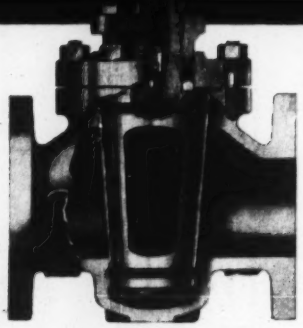
ROCKWELL Built
Nordstrom Valves
Lubricant-Sealed for Positive Shut-Off

Another Product

WALWORTH

LUBRICATED PLUG VALVES

Better because ... **They are *pressure sealed* with an insoluble lubricant readily renewed while the valve is in service. Lubricant completely surrounds the plug ports assuring a tight seal against leaks. It also insures ease of operation by reducing friction between the body and the plug while at the same time protecting the finished surfaces against corrosion and wear.**



Lubricant system of a Walworth No. 1700F Regular Gland, Wrench Operated, Steel-iron, *Lubricated Plug* Valve. Other Walworth *Lubricated Plug* Valves include Single Gland, and Ball Bearing types. Sizes to 30-inches — pressures to 5,000 psi, and for vacuum service.

Walworth Lubricated Plug Valves are the most satisfactory valves available for the handling of gritty suspensions, and many other destructive, erosive, and corrosive industrial and chemical solutions.

They are ideal for general refinery and pipeline service.

For full information see your Walworth Distributor, or write for your copy of Bulletin 111. Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.

WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD

Do you fit into this picture?

Opportunities in Guided Missile Engineering at North American Aviation:

ELECTRO-MECHANICAL

Microwave Antenna
Microwave Components
Radar
Computers
Fire Control
Servo-Mechanisms
Product Engineering
Standards Engineering
Technical Writing

AEROPHYSICS

Preliminary Analysis
Preliminary Design
Systems Analysis
Structures Engineering
Aeroelasticity & Flutter
Weight Engineering
Aerodynamics
Electrical Design
Flight Test Engineering
Flight Test Instrumentation

PROPULSION

Stress & Dynamic Analysis
Controls
Combustion Devices
Turbines & Pumps
Valves & Regulators
Field Test Engineering
Propulsion System Instrumentation
Propellant Research
Missile Power Plant Systems

At North American you will use the nation's finest experimental and test facilities: subsonic, supersonic, and tri-sonic wind tunnels, thermodynamic laboratory, electro-mechanical laboratories, rocket engine field laboratory.

Many opportunities for recent graduates, and a number of high-level positions are available to experienced engineers. You are invited to send your resume to: North American Aviation, Incorporated, Engineering Personnel Manager—12214 Lakewood Boulevard, Downey, California.

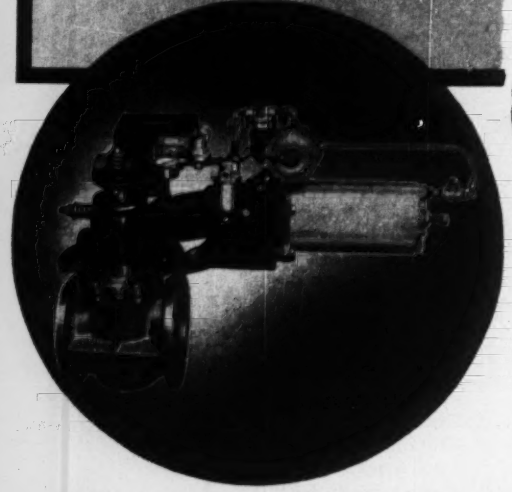
organization, facilities and experience keep

North American Aviation, Inc.

years ahead in aircraft . . . atomic energy . . . electronics . . . guided missiles . . . research and development.

DeZURIK VALVES...

THE "AUTOMATIC" CHOICE IN SO MANY NEW PLANTS!



With more and more plants turning to automation, more and more DeZurik Automatic Control Valves are being installed every day. There are good resons for choosing DeZurik. Here's the valve that operates efficiently on *any* line—vacuum or pressure; the valve that requires *no lubrication*, minimum maintenance; the valve that doesn't leak!

DeZurik Automatic Control Valves feature:

- excellent control characteristics
- straight-thru flow
- sizes from ½" thru 20"
- all castable metals

AND they're attractively priced!

DeZurik Automatic Control Valves are controlled by positioning type air or hydraulic operators. DeZurik's exclusive eccentric action is FRICTION-FREE, delivering drip-tight shut-off even with automatic operation.

Write for complete details and service recommendations.

DEZURIK SHOWER COMPANY — SARTELL, MINNESOTA

CLUTCH KNOW-HOW
AT YOUR SERVICE
ROCKFORD CLUTCH engineers have designed clutches, power take-offs and speed reducers for hundreds of different products. This wide experience can help solve your power transmission control problems. Just send a description or print of your needs for their recommendations.
SEND FOR THIS HANDY BULLETIN
Shows unique ROCKFORD CLUTCH and POWER TAKE-OFF applications. Contains diagrams, dimensions, capacity tables, etc.
ROCKFORD CLUTCH DIVISION
Borg-Warner Corporation
1307 Eighteenth Avenue, Rockford, Illinois
ROCKFORD CLUTCHES

MECHANICAL ENGINEERING CARD INDEX

November, 1954 — Vol. 76, No. 11

Engineered Safety, J. L. Young	878
Engineering Education in Russia, M. H. Trytten	882
Basic Conflicts in Engineering Education, Arthur Bronwell	886
Pressing Parts From Powdered Metals—A New Concept, B. B. Belden	891
ASA Code for Pressure Piping, by F. S. G. Williams	897
Professional Self-Development of Engineering Administrators, J. E. Walters	901
Economical Turbine Design for Marginal Hydroelectric Plants, A. R. Klann	905
Editorial	877
Briefing the Record	909
European Survey	922
ASME Technical Digest	924
Availability List for 1954 ASME Fall Meeting Papers	935
Comments on Papers	936
Reviews of Books	938
ASME News	940

OPPORTUNITY ADVERTISEMENTS

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications or a set of drawing instruments to dispose of; if you need help or want a position; in fact, anything to be offered that somebody else may want or anything wanted that somebody else may have—use a classified advertisement in the Opportunities Section.

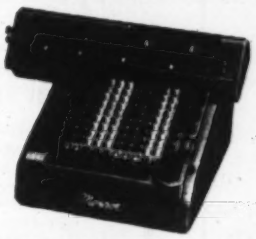
RATES

Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.70 a line, $1.35 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display matter carried in single column units of multiples of one inch at the flat rate of $28 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

The American Society of Mechanical Engineers
29 West 39th Street — New York 18, N. Y.

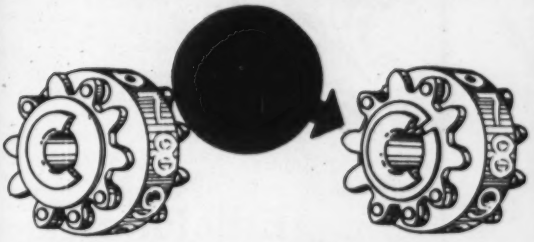
Waldes Truarc rings replace old-fashioned fasteners . . . save assembly time...end scrap loss...increase operating efficiency

This is the Monroe Calculator



...precision-engineered business machine made even more efficient, and less costly to manufacture through the use of Waldes Truarc Retaining Rings.

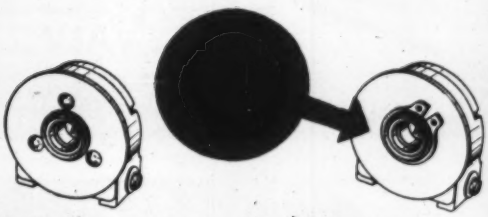
Multiplier Dial Assembly



Old Way. One-piece assembly was spun together. Spinning operation was costly, resulted in high scrap loss.

Truarc Way. Two-piece assembly is held together by one Truarc Ring (series 5108). Rejects: practically zero.

Electric Motor Governor



Old Way. Collector Disc assembly was formerly riveted, requiring skilled labor. Riveted Collector Disc could not be removed in the field.

Truarc Way. Truarc Ring (series 5100) replaces rivets, saves labor, material...improves Collector action. Collector Disc is easily replaced.

Intermediate Gear Shaft

Old Way. Washer riveted on end of assembly for zoning control. Costly, troublesome, hard to obtain critical zoning required.

Truarc Way. Truarc E-Ring (series 5133) cuts assembly time, virtually eliminates rejects and final assembly and zoning problems.

Monroe Calculating Machine Company, Orange, N. J. uses various types and sizes of Waldes Truarc Retaining Rings. Use of Truarc has helped eliminate scrap losses, saved on material and labor, and resulted in increased operating and servicing efficiency of the product. Monroe plans to use Truarc Rings for every possible fastening operation on their entire line!

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered...quick and easy to assemble and disassemble.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc Engineers for individual attention, without obligation.

SEND FOR NEW CATALOG

WALDES TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,902; 2,487,903; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

ME 126

Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N.Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

Name .....

Title .....

Company .....

Business Address .....

City ..... *Zone* ..... *State* .....

For Designs That Stress-

Efficiency
Economy
Automation

It's *SYNTRON*

EQUIPMENT

ELECTRIC VIBRATORS

Keep stubborn materials flowing freely through bins, hoppers and chutes. Automatically eliminate clogging, arching or plugging. Compact—easy to install—electromagnetic.

VIBRATORY FEEDERS

For controlled feeding—at rates from a few pounds to hundreds of tons per hour—of most materials from fine powders to heavy lumps.

SELENIUM RECTIFIERS

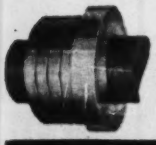
Have almost unlimited use wherever a-c to d-c power conversion is required. Efficient—low cost—require no warm-up.

PARTS FEEDERS

Automatically feed small parts of almost any shape or material—single file—in oriented position—at controllable speeds. Highly efficient for automation set-ups.

INFRA-RED HEATING PANELS

Heat by direct radiation—not by reflection. Heating efficiency remains constant for continuous production runs. No blind spots—flat, intense radiating pattern.



SHAFT SEALS

Positive sealing of gases and liquids around rotating shafts of pumps, turbines, mixers, etc. Self-lubricating—no repacking—sealing power increases in direct ratio to external pressure.

Write for complete Catalogue data—Free

SYNTRON COMPANY
498 Lexington Avenue Homer City, Penna.

INSTALL
peak performance
INTO YOUR
compressors
(AIR • GAS • AMMONIA)

Peak performance, maximum efficiency, greater output, and lower power costs can be built into your oldest, and of course your newest, compressors by the installation of VOSS VALVES.

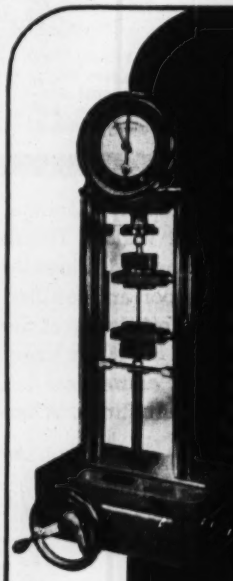
Check THESE
VOSS VALVE ADVANTAGES:

- Quiet, vibration-free operation
- 20 to 60% more valve area
- less power consumption
- minimum pressure loss
- normal discharge temperature
- lower operating costs
- utmost safety

Our detailed proposal for increasing the efficiency of your compressor will be sent you without obligation. Send us the name, bore, stroke, and speed of your machine.

J. H. H. VOSS VALVES
REG. U.S. PAT. OFF.

VOSS VALVES / J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.



Truly Universal

Precision Dillon Tester may be used in TENSILE, COMPRESSION, TRANSVERSE or SHEAR testing with equal accuracy. Hand operated or motorized, will test any type material in flats, rounds or special shapes. Seven capacities from 0-250 lbs. up to 0-10,000 lbs. Fully portable. Has self-aligning grips, maximum hand, ball bearings. America's most popular low priced tester! 6 to 8 DAY DELIVERY. Write today for illustrated brochure.

Dillon

TENSILE TESTER

ENGINEERING SKILL AT ITS HIGHEST!

W. C. DILLON & CO., INC. 14620Y Keswick St. Van Nuys, California (Suburb of Los Angeles)

What size is a quality fastener?

Here are two ELASTIC STOP® nuts.
Each has the familiar red locking collar. Each is self-locking, vibration-proof and can be reused many times. Each is a fast, readily assembled one-piece unit . . . will maintain accurate adjustment anywhere on a bolt. Each will afford positive protection against thread corrosion . . . prevent liquid seepage along bolts. Each is manufactured in quantity. Each is exactly controlled as to quality of raw material, finished dimensions, class of thread fit, seat squareness and finish. Each has a record for precision and uniformly high performance that is unmatched.

But . . . one measures 1/10 inch across the flats; the other, 4 inches. Between these two, there are more than 530 different hex nuts in the ESNA line. They are the result of variations in height, material, finish and size.

Look to ESNA for the top quality self-locking fastener that fits your need best.

ELASTIC STOP NUT CORPORATION OF AMERICA

ESNA TRADE MARK

ROLLPIN TRADEMARK

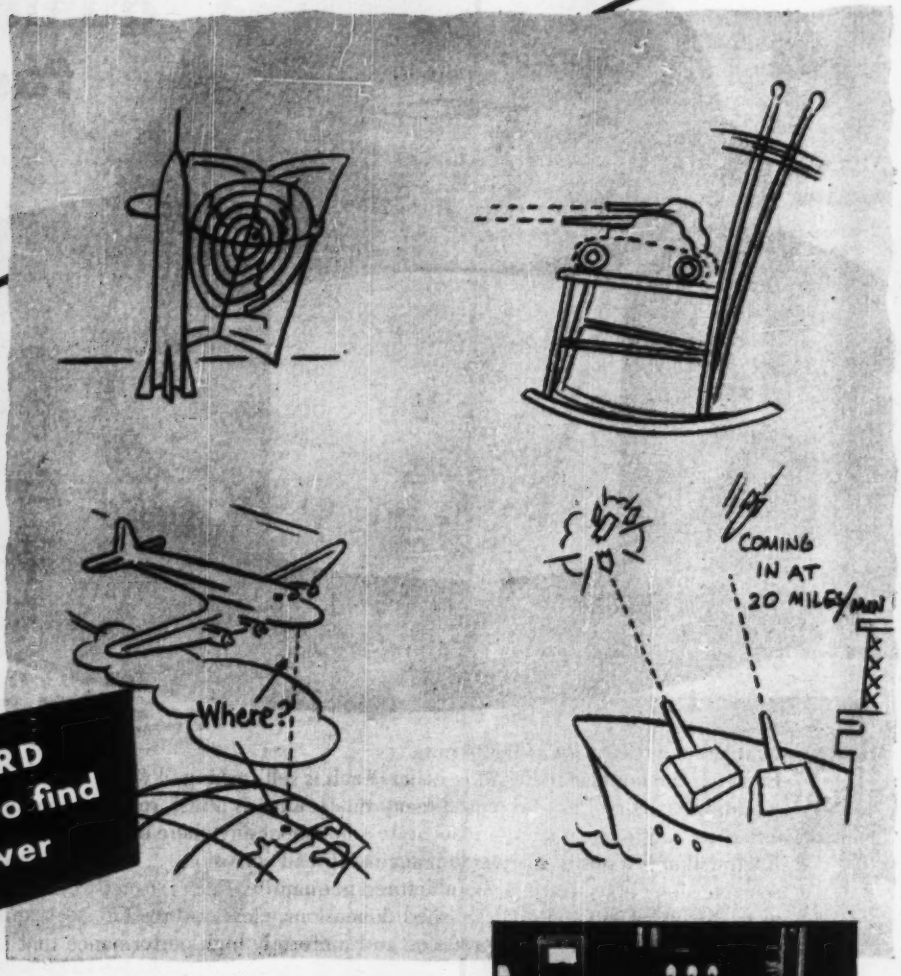
Elastic Stop Nut Corporation of America
Dept. N38-1211, 2330 Vauxhall Road, Union, N. J.
Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name _____ Title _____
Firm _____
Street _____
City _____ Zone _____ State _____

HOW CAN AUTOMATIC CONTROL
strengthen our defenses



...and FORD was asked to find the answer

MISSILE GUIDANCE . . . GUN STABILIZATION
AIRCRAFT NAVIGATION . . . WEAPONS SYSTEMS

The staff of engineers at Ford Instrument Company are experts in the field of automatic control. Every week, in the laboratories and shops of this large company thousands of men are working on electronic, hydraulic, mechanical and electrical servo-mechanisms, computers, controls and drives to solve problems for the Army, Navy and Air Force. Ever since Hannibal C. Ford started, in 1915, to develop and build the first gunfire computer for the U.S. Navy, Ford Instrument has been leading the way in applying the science of automatic control to America's defensive strength . . . and to American industry.

34

Each year the Ford Instrument Company is adding to its staff of several hundred engineers. If you are an engineer and can qualify, there may be a position for you.

FORD

FORD INSTRUMENT COMPANY
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

Why it pays to specify *The Leading Brand*

YOU SAVE three important ways when you specify TUBE-TURN Welding Fitting and Flanges. (1) You get the most advanced products available . . . assured by Tube Turns' pioneering research. (2) You get the exact fitting and flange for *your* problem promptly because Tube Turns has the world's most complete line . . . available nearby. (3) You get piping ideas through the outstanding Engineering Service and how-to-do-it information of Tube Turns.

These money-saving extras are yours when you specify "TUBE-TURN". Call your nearby Tube Turns' Distributor.

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

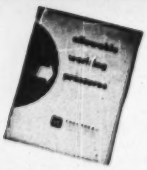
DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Chicago • Denver • Los Angeles
San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

TUBE TURNS'
Engineering Service
helps save $50,000

A LARGE PROCESSOR had a problem of retubing seven large cooling units, formerly fabricated from copper tubing and fittings. Thin-walled aluminum was considered as a replacement; however, there were no satisfactory methods for fabricating the metal.

Tube Turns' Engineering Service Division, working with Alcoa, came up with the solution. Special TUBE-TURN Elbows and a new brazing technique were developed and the problem was solved. Total saving by customer was $50,000. This engineering service is one of the extras you get when you do business with the leader . . . Tube Turns.

THE JOB. Brazing TUBE-TURN Aluminum Returns to aluminum tubing for cooling coils.



TUBE TURNS, Dept. F-6
224 East Broadway • Louisville 1, Kentucky

Please send free copy of booklet, "Allowable Working Pressures".

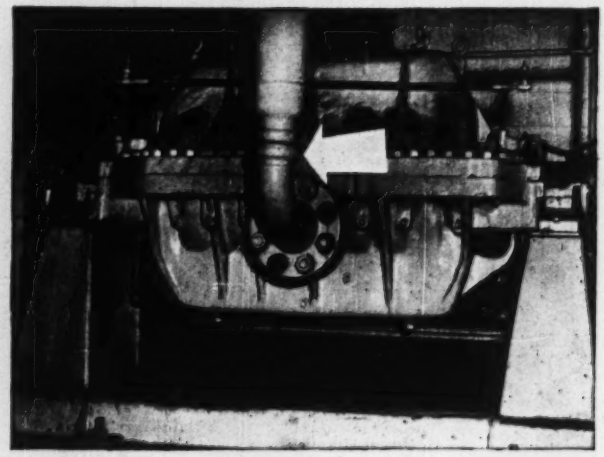
Company Name _____

Company Address _____

City _____ *Zone* ____ *State* _____

Your Name _____

Position _____



NEW HYDRAULIC COUPLING. This unique new TUBE-TURN Coupling for hydraulic piping eliminates weld scale and protrusions at joints, protects pumps and other precision equipment for lowest-cost operation. You are sure to get the latest cost-saving developments in fittings and flanges when you specify "TUBE-TURN".

YOU GET COMPLETE SERVICE. Your nearby Tube Turns' Distributor gives you the *exact* answer to your specific piping problem from the world's most complete line of welding fittings and flanges. It includes more than 4000 items . . . in all piping materials, schedules and sizes. This service is backed up by Tube Turns' engineering assistance.

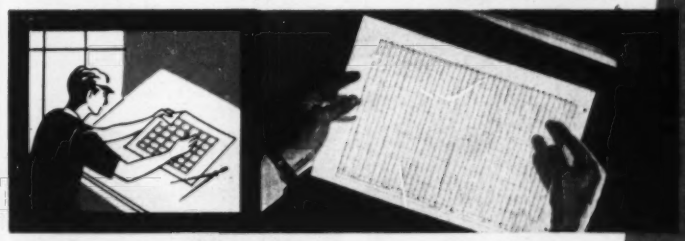
DISTRICT OFFICES

New York	San Francisco
Philadelphia	Seattle
Cleveland	Atlanta
Chicago	Tulsa
Denver	Houston
Los Angeles	Dallas
Midland, Texas	

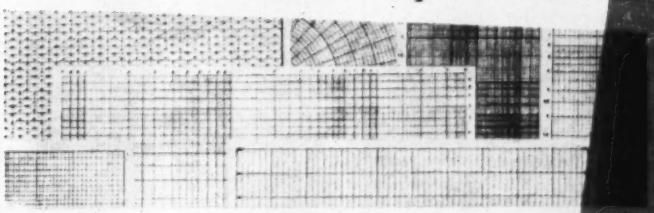
"®" and "TUBE-TURN" Reg. U.S. Pat. Off

TUBE TURNS
LOUISVILLE 1, KENTUCKY
A DIVISION OF NATIONAL CYLINDER GAS COMPANY

SEEING is BELIEVING!



TECHNICHARTS make sharper, faster reproductions



Available in all standard rulings, including:

Cross Section Forms — Logarithmic Forms
Mathematical Forms — Time Period Forms

and other popular rulings—Standard sheets—8½" x 11" and 11" x 17"

Ask your dealer for details and samples, or write:

CLEARPRINT PAPER CO.

1482 SIXTY-SEVENTH STREET · EMERYVILLE, CALIFORNIA

Technichart grades are printed on No. 1000E Clearprint, America's finest technical paper. To prove they're best, make this simple Clearprint test with a sample sheet...

1. **ERASES PENCIL AND PEN**—Try Technichart's perfect working surface with a 3H pencil. Then with a ruling pen. Notice the sharp, clean lines. The accurately printed soft-brown, dotted rules are especially easy on the eyes, ideal for photographic prints and ready printing.
2. **NO SMUDGE**—Erase and redraw several lines time and again. Fold the sheet repeatedly, too. Then hold it to the light, or make clearest possible reproductions.
3. **NEVER CHANGES**—Clearprint sheets in use throughout the country for 18 years prove its stable, unchanging character. The choice for permanent records.

If you are not using Clearprint Technichart now, please make this comparative test on the sheet paper you are using.

CLEARPRINT

TECHNICHART®

GRAPHIC CHARTS FOR PERFECT REPRODUCTIONS

...EXAMINE THIS HOSE COUPLER...
will it help YOU?

HOOK... PUSH... ...CLICK

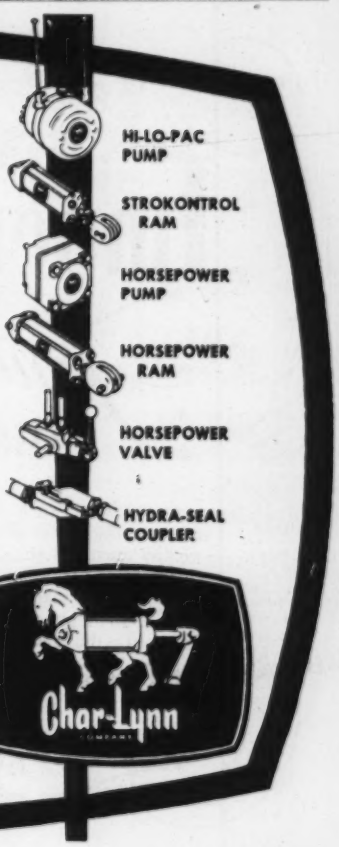
Instant Free Flow

NEW
Char-Lynn
HYDRA-SEAL HOSE COUPLER

The Char-Lynn Hydra-Seal Hose Coupler has been engineered and designed as a quick-connect self-sealing, break-away coupler for all fluid carrying hoses.

Operation of the Hydra-Seal Coupler is as simple as inserting or removing a plug from an electrical outlet. To couple, hook on and push together; to uncouple, pull apart; no tools are needed. As the barrels are hooked over the slide lugs and the coupler pushed together, the barrels displace the slides and the barrel ports are brought into register or alignment . . . thus allowing the free flow of fluid through the coupler. Pulling the coupler apart brings the slides into position over the ports—oil is sealed in, dirt sealed out.

Let Char-Lynn solve your coupler problems.

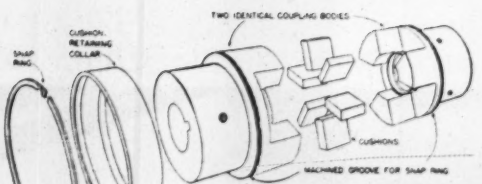


CHAR-LYNN COMPANY

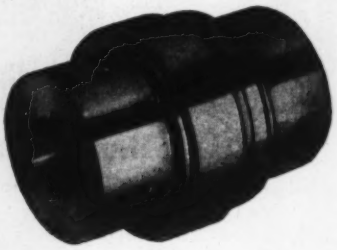
ME 12 2843-26th Avenue South, Minneapolis 6, Minnesota

Hydraulic Horsepower To Serve You Better

LOVEJOY
FLEXIBLE COUPLINGS



- **Quickly Installed**
- **Double-Life Cushions**
- **Permanent Non-Lubricating**



- Lovejoy's simple, rugged design permits easy, quick installation or removal. Load cushions are in plain sight at all times for rapid inspection and can be removed without tearing down the coupling.
- One-half the cushions act as idlers during operation, except on reversing loads. In non-reversing operation, the cushions can be reversed to double their service life.
- Lovejoy Couplings never require lubrication.
- Lovejoy manufactures a complete range of flexible couplings from fractional to over 800 hp. Get full information on this "maintenance-free" line, including catalog with complete specifications and operating capacities.

LOVEJOY FLEXIBLE COUPLING CO. 4832 W. LAKE ST. • CHICAGO 44, ILL.

Also Mfrs. of Universal Joints, Variable Speed Pulleys and Transmissions.

Imperial

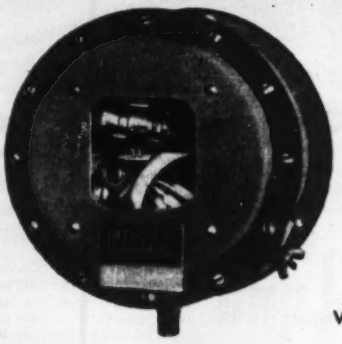
THE *Finest*

TRACING CLOTH

Imperial is known in drafting rooms all over the world as the traditional quality tracing cloth.

With the background of decades of experience, its makers have pioneered in modern improvements to maintain Imperial as the finest tracing cloth made.

MERCOID
PRESSURE CONTROLS
FOR OUTDOOR SERVICE



Weather Proof
Drip Tight
Semi-dust Tight
Sleet Proof
Splash Proof
Moisture Resistant
Rain Tight
Water Tight

Equipped with Sealed Mercury Contacts
External Adjustments
Visible Calibrated Dial

AVAILABLE IN 17 PRESSURE RANGES FROM

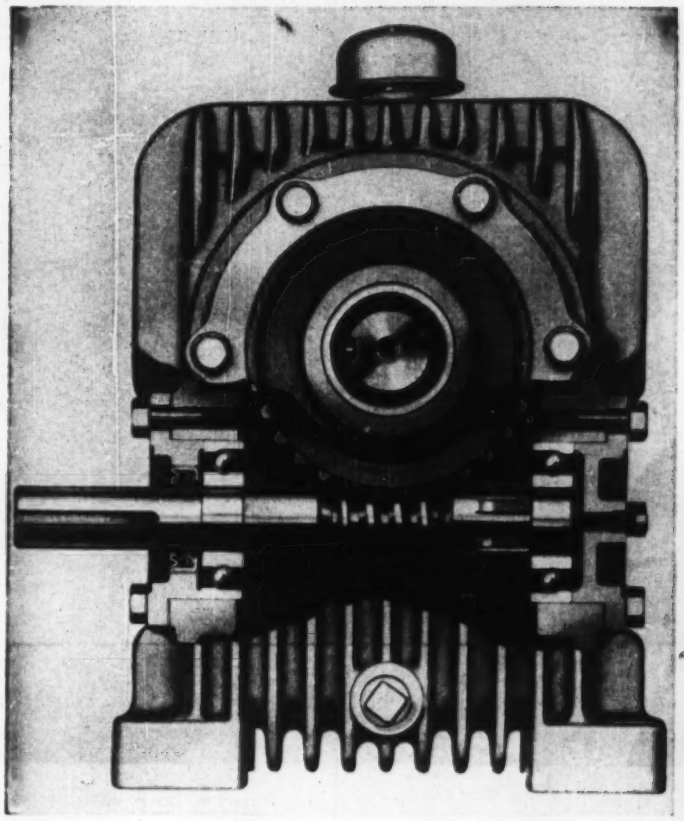
0-30" VAC. TO 300-2500 PSI.

WITH THE SENSITIVITY YOUR APPLICATION REQUIRES

Mercoid weather resistant controls are also available for temperature and liquid level applications.

Write for Bulletin 14PW

THE MERCOID CORPORATION
4201 BELMONT AVE. CHICAGO 41, ILLINOIS U.S.A.

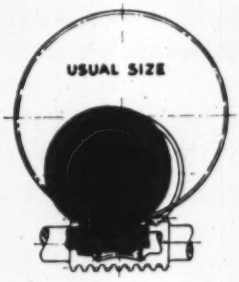


MORE HP PER POUND

MORE HP PER CUBIC INCH

MORE HP PER DOLLAR

You're looking at the "innards" of the most efficient worm geared speed reducer available today. It's Cone-Drive Gear's exclusive double-enveloping worm gear design, which means more load-carrying capacity, size for size, than any other type of right-angle speed reducer.



This simple design, with the gear and worm literally "wrapped" around each other, means a space and weight savings that often makes the difference between a compact, efficient product and just another machine.

You can specify (from stock) any one of 190,000 standard models of Cone-Drive gears to handle loads from fractional to 800 hp. You can have ratios from 5:1 to 4900:1. Fan-cooled or water-cooled models available if you should need them.

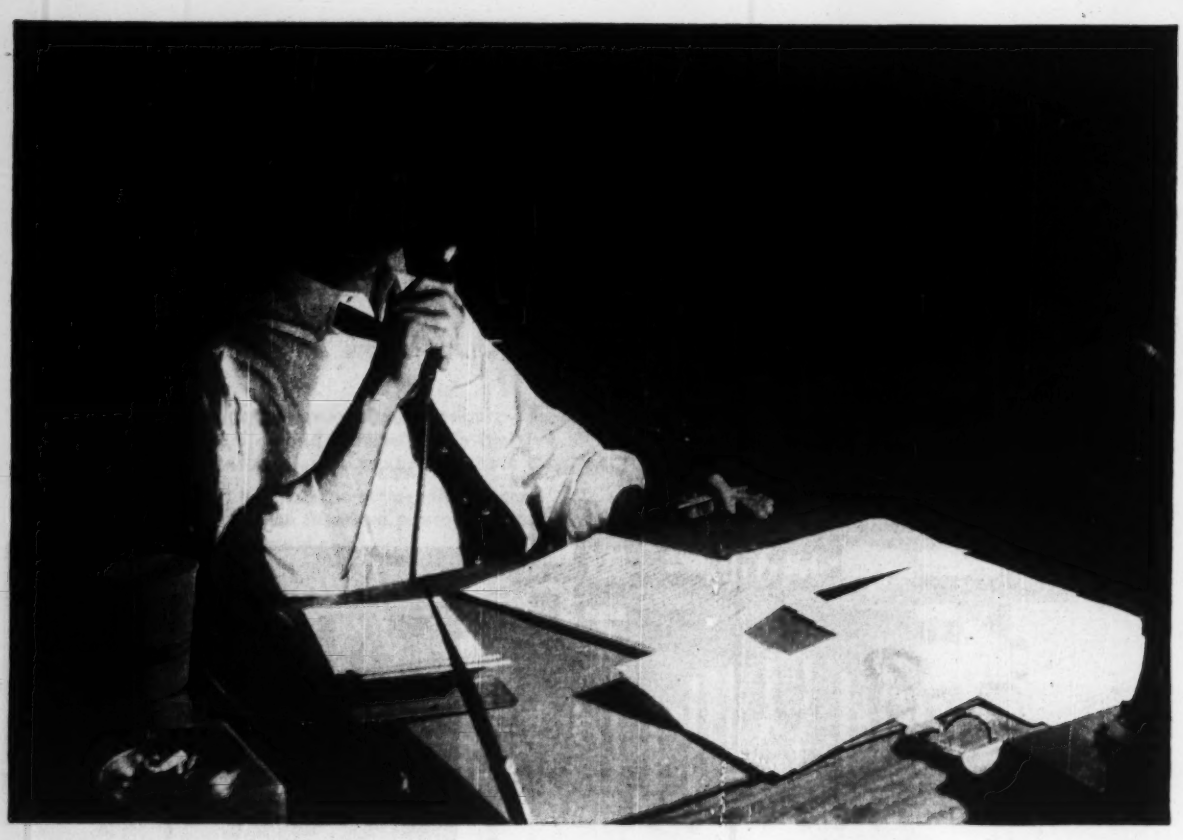
Interested? Get complete details in Bulletin 8901-50.

CONE-DRIVE GEARS

Division, Michigan Tool Company

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, Michigan



"We've been in the dark"

"Miss Jones—

"These notes cover what I intend to discuss at the committee meeting tomorrow. Please type them and attach them to the Wolverine proposal we received this morning. And set up my office for a 10:00 meeting tomorrow."

• • •

"Gentlemen:

"As you know we've been in the dark for some time as to how best increase the capacity of our heat exchangers. Space is at a premium, and the obvious answer of a larger heat exchange unit is out of the question.

"I've been talking to some of the men at Wolverine Tube and they've come up with what looks like the answer. They suggest using Wolverine Trufin*—their integral finned tube. Wolverine extrudes the fins right from the tube wall: Trufin is just about the most efficient tube I've ever seen. We can boost our output, improve our product at the same time.

"There are other advantages, too. Trufin can be bent or coiled just as easily as plain tube. In order to meet varying corrosive conditions, it's made in several metals: copper and copper-base alloys, aluminum, electric-welded and stainless steel, bi-metal and others.

"I've prepared some rough figures to show just what cost advantages we can expect from Wolverine. They've given me a quotation, too, which I'd like to go over with you." Wolverine Tube, 1483 Central Avenue, Detroit 9, Michigan.

EST 1916

WOLVERINE TUBE

DIVISION OF CALUMET & HECLA, INC.

Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

*REGISTERED U. S. PATENT OFFICE

Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ont.

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, N. Y.

Consider the value of Graphitization studies...

...when critical power piping is the order

This is one field where gouging pays off handsomely . . . at least when it's done by the device pictured above, a weld prober which gouges out boat-shaped samples of metal from piping that has seen lengthy service under high-temperature, high-pressure conditions.

When these samples are polished, etched, and then diagnosed under metallographic microscope their evaluation provides basic information in studies of graphitization, the phenomenon which prior to 1943 was considered of only academic interest.

Through the microscope and by means of mechanical tests Kellogg metallurgists carry on a continuous search for evidence of graphitization. They are hunting particularly for what they call the "eyebrow" or chain type of graphite. It is these malformations that cause planes of weakness in carbon steel and carbon moly power piping . . . weaknesses that can result in serious failures.

Although exactly why graphite forms is not definitely known, metallurgists have already come up with positive methods of inhibiting it. Still Kellogg specialists continue their research, endeavoring to pinpoint the exact causes of graphitization and to improve fabricating techniques and materials. More than 6,000 test pieces have been gouged out of actual service piping and evaluated by Kellogg technicians in the past decade.

Continual metallurgical research such as this graphitization program is just one of the basic reasons why any utility company obtains a valuable plus when it specifies . . . *main steam and reheat piping by Kellogg.*

* * *

New Power Piping Booklet Published . . . Send for descriptive literature about Kellogg's extensive facilities for assuring the highest quality workmanship. A section of the booklet is devoted to detailed coverage of the K-Weld* process.

OTHER FABRICATED PRODUCTS include: Pressure Vessels . . . Vacuum Vessels . . . Fractionating Columns . . . Drums and Shells . . . Heat Exchangers . . . Process Piping . . . Bends and Headers . . . Forged and Welded Fittings

FABRICATED PRODUCTS DIVISION

THE M. W. KELLOGG COMPANY

225 Broadway, New York 7, N. Y.

In Canada—**The Canadian Kellogg Company, Limited, at Toronto and Edmonton**

In Europe—**Kellogg International Corporation, at London**

*rade-mark of The M. W. Kellogg Company

KELLOGG PULLMAN

KELLOGG
HIGH TEMPERATURE
HIGH PRESSURE
POWER PIPING
KELLOGG
HIGH TEMPERATURE
HIGH PRESSURE
POWER PIPING
KELLOGG
HIGH TEMPERATURE
HIGH PRESSURE
POWER PIPING
KELLOGG
HIGH TEMPERATURE
HIGH PRESSURE
POWER PIPING

Here's why the Ljungstrom saves fuel...improves boiler performance

1. **Saves Fuel** — Savings are roughly 1% for every 45-50°F of preheat, since this heat has been recovered in usable form from flue gases.

2. **Increases Boiler Output** — Preheating combustion air increases boiler furnace temperature. Heat absorption into boiler tubes increases at the same time, raising the unit's capacity to produce steam.

3. **Increases Boiler Reliability** — Preheating leads to more complete combustion of fuel; therefore, less slagging. By burning fuel more completely, it helps boilers stay on the line longer. Furthermore, gases to dust recovery units are cleaner.

4. **Permits Use of Lower Grade Fuels** — Saw and paper mill refuse, wood, lignites, peat, bagasse and similar low-grade fuels become commercially practical when preheated combustion air is used.

The Ljungstrom® Air Preheater . . . used in seven out of ten large boiler installations—is the most compact, reliable and versatile preheater available. Installed in a boiler, it leads to the four well-known advantages listed at the left.

Remember: the ability to deliver these important benefits in full measure is an important reason why more than twice as many Ljungstrom Air Preheaters are specified for large boilers than all other types combined.

Representatives—Sales Agencies
Business for Sale
Partnership—Capital
Manufacturing Facilities

OPPORTUNITIES

Positions Open—Positions Wanted—Equipment, Material, Patents, Books, Instruments, etc. Wanted and For Sale

Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

POSITIONS OPEN

PROJECT ENGINEER

Desirable opening for graduate Mechanical Engineer with 2-3 years' experience. Investigation and estimating for maintenance and new construction included among other phases of project engineering. Send resume, including salary requirements to:

Davison Chemical Company
Curtis Bay Works
Balto. 26, Md.

QUALIFIED SALES ENGINEER

For Isocyanate program. Experience in plastics and polyesters preferred but not essential. Background in mixing, spraying and applying resinous systems desired. Training period for proper man. Eventual travel.

Address CA-4841, % "Mechanical Engineering."

MECHANICAL ENGINEERS DESIGN

Several excellent opportunities available for graduate mechanical or chemical engineers with 3 to 5 years' experience, preferably in mechanical or chemical equipment design.

Positions open in Fredericksburg, Va., and in Marcus Hook, Pa., (near Philadelphia).

Send résumé giving in detail qualifications and salary desired to:

Personnel Recruitment Department
American Viscose Corporation
1617 Pennsylvania Boulevard
Philadelphia 3, Pa.

OPPORTUNITY FOR CREATIVE **ENGINEERS**

in RESEARCH & DEVELOPMENT of MISSILE PROPULSION SYSTEMS

EXPERIMENT INCORPORATED offers outstanding opportunities in a rapidly expanding organization, where emphasis is placed on individual responsibility and career advancement.

PROJECT ENGINEERS
MECHANICAL DESIGNERS
STRESS & VIBRATION ANALYSTS
DESIGN DRAFTSMEN
TECHNICAL REPORTS SUPERVISOR

Located on the banks of the picturesque James River in suburban Richmond, with the most modern facilities combined in a productive and congenial atmosphere.

EXPERIMENT INCORPORATED
RICHMOND 2, VIRGINIA

RATES Classified Advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.70 a line. $1.35 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display Advertisements carried in single column units of multiples of one inch at flat rate of $28 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

SENIOR FURNACE ENGINEER

The design of furnaces to improve process service requires exceptional training and ability. We'd say the minimum was an ME or ChE degree, 8 years' background in furnace design, and a thorough knowledge of heat transfer fluid flow, chemical reaction, metallurgy and strength of materials as applied to furnace design.

The ability to recommend desirable process changes, to develop new designs and design methods requires additional talents as well as initiative.

If you can meet these exacting qualifications, we'd like to meet you. The result can be mutually profitable.

Box #506, Room 1201
230 West 41 St., New York 36, N. Y.

CONTROLS ENGINEER

BS or MS in Mechanical Engineering. Design and specification of control systems and components for power and process plants and equipment. Prefer background of several years' experience in chemical or petroleum field.

Other opportunities exist from time to time in our well established firm in connection with the design of general industrial installations, power plants, electrical facilities, advanced test facilities, bridges, buildings and highways.

Please write fully to

SVERDRUP & PARCEL, INC.
Consulting Engineers
915 Olive St. Louis 1, Mo.

Propulsion and Thermal Power Systems

The Ramo-Wooldridge Corporation, Los Angeles, offers opportunities in guided missile research and development to qualified engineers and scientists

in the fields of

THERMODYNAMICS
HEAT TRANSFER
MECHANICAL DESIGN
FLUID FLOW
LIQUID PROPELLANTS
HIGH TEMPERATURE METALLURGY

Send inquiry to:

The Ramo-Wooldridge Corporation

DEPT. ME-M, 8820 BELLANCA AVENUE, LOS ANGELES 45, CALIFORNIA

Consideration must be given to whether relocation of applicant will disrupt other important military work

ENGINEERS

The APPLIED PHYSICS LABORATORY OF THE JOHNS HOPKINS UNIVERSITY offers an exceptional opportunity for professional advancement in a well-established laboratory with a reputation for the encouragement of individual responsibility and self-direction. Our program of

GUIDED MISSILE DEVELOPMENT

provides such an opportunity for men qualified in:

SERVO MECHANISMS
MISSILE SYSTEMS DEVELOPMENT
HYDRAULIC CONTROL SYSTEMS
ENVIRONMENTAL AND FLIGHT TESTING
MECHANICAL COMPONENT DESIGN
AERODYNAMICS AND COMBUSTION

Please send your resume to G. B. Mayfield

APPLIED PHYSICS LABORATORY
THE JOHNS HOPKINS UNIVERSITY
8621 Georgia Avenue
Silver Spring, Maryland

Electro-Mechanical Engineers
Mechanical Engineers

required for work in the development of

Airborne
Digital Computer Systems

involving

CONVERSION DEVICES
MEMORY SYSTEMS
SUB-MINIATURIZATION
PACKAGING

The Ramo-Wooldridge Corporation

Dept. ME-C, 8820 Bellanca Avenue, Los Angeles 45, California

Consideration must be given to whether relocation of applicant will disrupt other important military work.

CONVAIR
POMONA
offers
ENGINEERING OPPORTUNITIES

- **ELECTRONICS**
- **DYNAMICS**
- **AERODYNAMICS**
- **THERMODYNAMICS**

Guided Missiles

Employment Dept.
1675 West 5th St.
P. O. Box 1011, Pomona, Calif.

CONVAIR
A DIVISION OF
GENERAL DYNAMICS CORPORATION
(POMONA)

CAREER OPPORTUNITIES
in
NUCLEAR REACTOR TECHNOLOGY

Our expanding reactor program is creating new, outstanding research and development opportunities for capable young men with appropriate training, experience, or interests in reactor physics, instrumentation, and engineering. These are career openings in a stable, progressive organization involving both Government and industrial applications of atomic energy. Apply now for prompt, confidential consideration to

BATTELLE MEMORIAL INSTITUTE
505 King Avenue Columbus 1, Ohio

MECHANICAL ENGINEERS

Engineers needed for the design, supervision of fabrication and installation, and initial operation of research and prototype production equipment.

Apply direct to W. S. Peterson,
Process Metallurgy Section
Department of Metallurgical Research
Kaiser Aluminum & Chemical Corporation
Spokane 69
Washington

MAKE USE OF THE OPPORTUNITIES SECTION

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—use a classified advertisement in MECHANICAL ENGINEERING for quick results.

Result of diversification:

Vertical Rising Aircraft

Lockheed increases engineering staff

Diversification at Lockheed is resulting in more and better careers for engineers.

New career positions have been created by such diverse projects as radar search planes, turbo-prop and turbo-compound transports, jet transports, vertical rising aircraft, extremely high speed jet fighters, trainers, patrol bombers and a number of classified activities.

To the career-conscious engineer, this diversified development and production program means: 1) more job security and 2) more opportunity for promotion with so many projects in motion.

Positions open include:

DESIGN ENGINEERS

at all levels for creative design in structures, hydraulics, mechanical and electrical fields.

Requirements: An engineering degree or equivalent experience; some aircraft experience preferred.

STRESS and STRUCTURES ENGINEERS

at all levels to perform analysis of structural and mechanical components which determine design criteria.

Requirements: An engineering degree and experience in aircraft structures or related fields.

WEIGHT ENGINEERS

to perform weight analysis and projections during preliminary design, production design and flight test.

Requirements: A degree in engineering, mathematics or physics with experience in weight control and estimations.

Radar Search Plane

Super Constellation Airliner

Jet Trainer

Neptune Patrol Bomber

Turbo-Prop Transport

Training Program for Non-Aircraft Engineers
Aircraft experience is not necessary to join Lockheed. An engineering degree or equivalent experience qualifies you to receive transitional or on-the-job training—at full pay.

Lockheed offers you increased salary rates now in effect; generous travel and moving allowances; an opportunity to enjoy Southern California life; and an extremely wide range of employee benefits which add approximately 14% to each engineer's salary in the form of insurance, retirement pension, sick leave with pay, etc.

Those interested are invited to write E. W. Des Lauriers for an application blank and illustrated brochure describing life and work at Lockheed. Coupon below is for your convenience.

Mr. E. W. Des Lauriers, Dept. ME-11
Lockheed Aircraft Corporation, 1708 Empire Ave., Burbank, Calif.
Dear Sir:
Please send me your Lockheed brochure describing life and work at Lockheed in Southern California.

MY NAME _____

I AM INTERESTED IN ... *(name position in this advertisement which fits your training and experience)* _____

MY STREET ADDRESS _____

MY CITY AND STATE _____

Lockheed
Aircraft Corporation
Burbank **California**

POSITIONS OPEN

Continued from Page 119

Engineer
Are You One of Three Men

we are seeking to fill these important openings? All are in the field of

VIBRATION AND MECHANICAL METALLURGY

These positions require men with a degree in either mechanical, metallurgical, aeronautical or electrical engineering, theoretical and applied mechanics, or physics. In addition—

ONE POSITION REQUIRES . . .

A man with formal education in vibration analysis with emphasis on theoretical approach.

THE SECOND POSITION REQUIRES . . .

A man with practical experience in solving vibration problems either on rotating machinery or aircraft equipment.

THE THIRD POSITION REQUIRES . . .

Some knowledge of the study of fatigue of metals and fatigue testing techniques. Also familiarity with methods of experimental stress analysis.

We are rapidly expanding our established line of

JET AIRCRAFT EQUIPMENT

including such items as starters, fuel controls, hydraulic pumps, cockpit cooling units, etc., in addition to our new

TURBINE ENGINE PROPELLERS

These positions offer excellent salary and job security as well as fine chance for advancement as our program grows. Our new plant is ideally located midway between Hartford, Conn., and Springfield, Mass. We help you to locate a home in either urban or rural areas and to pay moving expenses.

All replies held in strict confidence. Please send a complete resume of your experience including salary requirements to Mr. A. J. Fehlber at

HAMILTON STANDARD
Division of
United Aircraft Corp.
33 Bradley Field Road
Windsor Locks, Conn.

RESEARCH ASSISTANT—wanted February 1, 1955. Opportunity to do Ph.D. research in Engineering Mechanics by participating in contract research concerned with a theoretical investigation in the general field of stress waves due to large initial disturbances. Good background in fundamentals of mathematics and mechanics required. Reply to Norman Davids, Department of Engineering Mechanics, Pennsylvania State University, State College, Pa.

ENGINEERS—College positions, Feb. and Sept. Vacancies. All sections U.S., all fields of engineering. Openings for B.S., M.S., and Ph.D. Excellent salaries. Send pictures and qualifications to Cline Teachers Agency, Box 607, East Lansing, Mich.

ASSISTANT CHIEF ENGINEER—for graduate mechanical engineer, under 50 years of age, having minimum of 15 years good industrial plant experience. Position entails wide range of engineering work including operation and maintenance of boilers, milling plant, sugar processing equipment and corollary facilities. Large American-owned sugar company operating in Cuba. Good quarters furnished by Company. Salary not subject to U.S. income taxes under present laws. Reply giving complete details, stating age, marital and military status, experience, technical training and salary requirements. Reply will be held confidential. Address CA-4882, care of "Mechanical Engineering."

TEACHING STAFF—Instructors and assistant professors to teach engineering drawing, descriptive geometry, machine tool laboratory, analytical mechanics, thermodynamics, mechanical power laboratory, and senior elective courses at midwestern university. Appointments available immediately or in September. Address CA-4881, care of "Mechanical Engineering."

Superintendent of Grounds and Buildings. Age 30-45. Degree in mechanical engineering plus practical experience in supervising construction or maintenance of mechanical equipment, or an equivalent combination of education and experience. Salary range $4980-6360. Contact Personnel Office, University of California, Davis, California.

MECHANICAL ENGINEER—for supervisory position in Maintenance Department of large Western Pennsylvania Chemical Plant. Excellent opportunities for advancement. Three to five years' experience desirable. Reply giving age, education, experience, and salary requirement. Address CA-4897, care of "Mechanical Engineering."

INSTRUCTOR—in mechanical engineering subject. Good opportunities, begin Feb. 1st. Salary depends on qualifications. Address Rose Polytechnic Institute, Terre Haute, Indiana.

REFINERY ENGINEERS

for MAJOR OIL COMPANY. Several openings for Chemical, Mechanical and Civil Engineers in the following fields:

- **Process Design**
- **Refinery Technical Service**
- **Product Quality Control & Development**
- **Refinery Design and Project Engineering**
- **General Engineering of Refining Plants**
- **Refinery Utilities Engineering**

Candidates should meet the following requirements:

- **3 or more years experience in any of above listed fields.**
- **Draft exempt.**
- **Interested in possibility of future overseas service.**
- **Bachelor's or Master's degree in Engineering from recognized technical college or university.**

Salary commensurate with background and experience. Complete employee benefits plans.

Send detailed résumé to:

CA-4875, % "Mechanical Engineering."

EMPLOYMENT AGENCIES AND SERVICE BUREAUS

PLANT PERSONNEL, ENGINEERS, DESIGNERS—Draftsmen, Chemists, and Metallurgists, E. G. Stroud, Member ASME and President of Cleveland Engineering Agency Co., 2132 E. 9th St., Cleveland 15, Ohio, will help you find positions or men.

SALARIED PERSONNEL $3,000–$25,000

This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions, assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited.

JIRA THAYER JENNINGS
Dept. J, 241 Orange Street, New Haven, Conn.

SALARIED POSITIONS $5,000 to $35,000. We offer the original personal employment service (established 44 years). Procedure of highest ethical standards is individualized to your personal requirements. Identity covered, present position protected. Ask for particulars.

R. W. BIXBY
662 Brisbane Bldg. **Buffalo 3, N. Y.**

REPRESENTATIVES AVAILABLE

AGGRESSIVE SALES COVERAGE IN SOUTHERN CALIFORNIA—Registered professional M.E. with established contacts now selling to industrials, aircraft and gov't. facilities, can handle additional line. Ten years's sales engineering experience, last 5 years in this area. Experienced with electrical and mechanical equipment. Address CA-4888, care of "Mechanical Engineering."

Steam specialties, oil and gas burners, industrial equipment **PROFESSIONAL ENGINEER**, member ASME and AIME, offers representation in Venezuela. Over twenty years in design, construction, and sales. Address CA-4894, care of "Mechanical Engineering."

POSITIONS WANTED

MANAGER—ENGINEER
Development—Production

Outstanding, proven record of process and product development, cost reduction, quality improvement. Broad experience in mechanical and chemical products. Ten articles, fifteen patents, PhD training, excellent health, age 38. Challenge must offer $12,000.

Address CA-4880, % "Mechanical Engineering"

MECHANICAL-METALLURGICAL ENGINEER—26, Married, Veteran. B.S. Mech. Engr. June 53, M.S. Met. Engr. to be conferred Feb. 55. Pi Tau Sigma, Tau Beta Pi. 1 1/2 yr. exp. in metallurgical research. Resumes on request. Desires position in research or development in Eastern U.S. about Jan. 15. Address CA-4874, care of "Mechanical Engineering."

MECHANICAL ENGINEER—BSME, age 34, married. 5 years' varied development experience in aircraft, photographic, plastics industries. 6 1/2 years' specialized development work in materials handling devices, and some work with freight cars. Though satisfactorily employed at present, would like position with more responsibility and field contact. Prefer materials handling area. Address CA-4870, care of "Mechanical Engineering."

ELECTRICAL ENGINEER—B.S. in E.E., age 36, 10 years' experience with leading steam generator mfr.; responsible for selection and approval of instrumentation, combustion controls, motors, starters and other auxiliary equipment. Desires position with progressive company in or near large city. Address CA-4872, care of "Mechanical Engineering."

MECHANICAL ENGINEER—Age 41, BSME, MSME. 12 years diversified activities in automotive and aircraft production engineering, tool engineering, process engineering, tool analysis and tool coordination as well as extensive metal cutting research and development experience. Desires position on supervisory or staff level. Resident—Mich. Location open. Address CA-4878, care of "Mechanical Engineering."

MECHANICAL ENGINEER—5 years' experience as plant project engineer in manufacture of glass and ceramics. Design experience in handling, packaging, automatic forming machinery. Supervisory experience in Plant Engineering and Quality Control. Desires job leading to Chief plant engineer or Plant Manager. Address CA-4883, care of "Mechanical Engineering."

MECHANICAL ENGINEER—desires domestic or foreign employment based on 20–30 hour week. Experience as follows: 2 yrs. coordinating expansion of turbine laboratory facilities, including specification and report writing, and estimating. 3 yrs. supervisor in steel mill. 2 yrs. in manufacture of power-plant equipment. Age: 28, Single, BSME. Address CA-4885, care of "Mechanical Engineering."

PIPING ENGINEER—BSME, Radiographer. Age 31, Married. Experienced in planning, fabrication, erection and testing of plumbing, process and power piping. Desires permanent position. Foreign assignment will be considered. Available Jan. 1. Address CA-4887, care of "Mechanical Engineering."

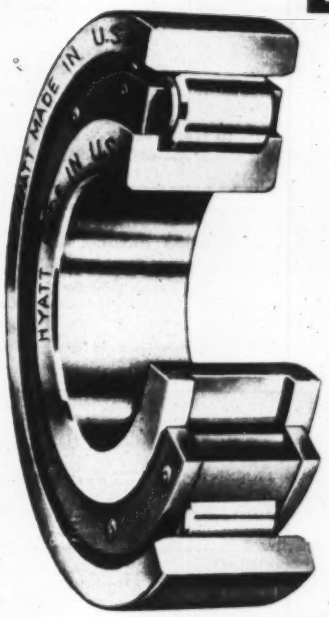
THIS IS NOTHING FOR YOU—unless you need a reliable man in Europe. You can have a "flying" sales engineer covering your entire European market with the "know-how" which can be obtained only in your own shop, helping your agents keep old customers and get new customers by putting things right—at surprisingly low cost. Am Swedish, 33, single and BSME. I am widely travelled and speak English, German, Swedish and some French. Give me some training time in your shop, fair pay and I am ready to go anywhere—any time. For further information write CA-4895, care of "Mechanical Engineering."

ENGINEER, MECHANICAL, AERONAUTICAL—10 years' experience in design and development of gas turbines, precision machinery and high pressure hydraulic systems and mechanisms. Desires a position which is challenging. Address CA-4899, care of "Mechanical Engineering."

Additional Opportunities are offered in the display advertisements—

on pages 46, 48, 52, 54, 60, 62, 64, 73, 75, 103

ANOTHER VERSATILE HY-LOAD BEARING . . .

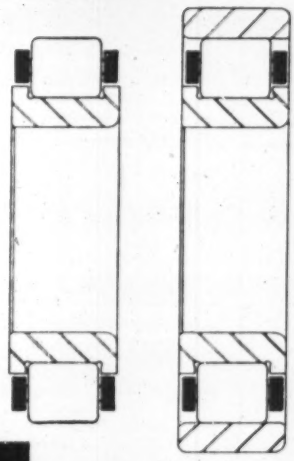


BU-Z

B indicates composite cage type—rollers spaced by conforming bars riveted to end rings

U indicates that the inner race has flanges at both ends to retain and align the rollers

Z indicates a separable straight cylindrical outer race



The Hyatt BU-Z Bearing is one of two basic Hy-Load types featuring a separable, interchangeable outer race, and is available in four series: 1200, 1300, 5200 and 5300.

Type BU-Z is designed for radial loads where the roller and inner race assembly must be kept with the shaft. The outer race may be omitted entirely, with rollers operating directly on the suitably hardened housing bore. This permits the use of larger-diameter shafts for greater rigidity—or smaller, more economical bearings.

Today thousands of products run smoother and last longer with less upkeep because of Hyatt Hy-Loads. If you're not already profiting from their use, contact your nearest Hyatt sales-engineer or write today for our Catalog No. 150. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

STRAIGHT ○ BARREL ○ TAPER ○

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, N. J.

RATES One Inch, Card Announcements inserted at a rate of $20.00 each issue, $15.00 per issue on yearly contract.

CONSULTING SERVICE

Manufacturers of Equipment Not Included

BLACK & VEATCH
CONSULTING ENGINEERS
Electricity—Water—Sewage—Industry
Reports, Design, Supervision of Construction
Investigations, Valuation and Rates
4706 Broadway — Kansas City 2, Missouri

GEORGE H. KENDALL
Consulting Mechanical Engineers
Methods Studies: Process of Product
Redesign Existing Products for Greater Profit
Trouble Shooting Production, Design, Cost Problems.
Specialist Automatic Machinery Processes, Controls,
New Developments, Patent Studies, Investigations,
New Products & Process Engineering Studies.
P. O. Box 3 (*Est. 1923*) Tel. Darien 5-1504
Noroton Heights 3 Offices Darien, Connecticut

PROPANE GAS PLANTS
and
Anhydrous Ammonia Plants
PEACOCK CORPORATION
Box 268, Westfield, N. J. Westfield 2-6258

Electrical Testing Laboratories, Inc.
Electrical, mechanical, photometric, radiometric and chemical laboratories, rendering testing, research and associated services, including certification, inspections at factories and field investigations.
2 East End Avenue at 79th St., New York 21

The Fuljian Corporation
ENGINEERS • CONSTRUCTORS • CONSULTANTS
POWER PLANT SPECIALISTS
UTILITY • INDUSTRIAL • CHEMICAL
1200 N. Broad St., Phila. 21, Pa.

Consult **Z. H. POLACHEK**
Reg. Patent Attorney
1234 Broadway
(at 31st St.) New York 1, N. Y.
Phone LO-5-3088

GILBERT ASSOCIATES, INC.
Engineers • Consultants • Constructors
607 Washington St.
Reading, Pa.
Engineering and Design
Industrial • Sanitary • Chemical
Economic Research
Industrial Relations
New York • Philadelphia • Washington

PETER F. LOFTUS CORPORATION
Engineering and Architectural
Consultants and Designers
First National Bank Bldg.
Pittsburgh 22, Pennsylvania
Cable Address—"LOFTUS Pittsburgh"

SIDNEY REIBEL, M. E.
CONSULTING ENGINEER
Materials Handling
Plant Layout — Special Equipment Design
Detroit Methods
32248 Queensboro — Farmington, Michigan

HARZA ENGINEERING COMPANY
CONSULTING ENGINEERS
E. Montford Fucik — Calvin V. Davis
Richard D. Harza
Hydroelectric Plants and Dams
Transmission Lines
Flood Control Irrigation
River Basin Development
400 West Madison Street — Chicago 6

Model Building
Working Models — Miniature
Models — Prototypes — Cutaways
Appearance Models — Mock-ups
write for brochure
MAST DEVELOPMENT CO. INC.
2212 E. 12th St. DAVENPORT, IOWA

SANDERSON & PORTER
ENGINEERS & CONSTRUCTORS
New York • Chicago • San Francisco

C. M. HATHAWAY
CONSULTING ENGINEER
Project Engineering, Product Development, Production Designs, Laboratory and Shop Facilities for Research, Model Work, and Pilot Manufacturing
1315 S. Clarkson Street — Denver 10, Colorado

WELD TESTING
Qualification of Operators—Supervision
Inspection—Research
NATIONAL WELD TESTING BUREAU
Pittsburgh Testing Laboratory, Pittsburgh, Pa.

Power Plants, Structures
Transmission Systems
Design, Supervision, Inspection
Appraisals, Reports
SARGENT & LUNDY
140 S. Dearborn St., Chicago, Ill.

JACKSON & MORELAND
Engineers and Consultants
Design and Supervision of Construction
Reports—Examinations—Appraisals
Machine Design—Technical Publications
BOSTON — NEW YORK

An announcement in this

section will acquaint others

with your specialized practice.

J. E. SIRRINE COMPANY
Engineers
Design and Supervision of Steam and Hydro-Electric Power Plants. Industrial Plants, Mechanical and Operating Surveys, Appraisals • Plans • Reports
Greenville, South Carolina

M. W. KELLOGG
Piping System Design Analyses
Unique piping system model tester as well as modern IBM card programming computer available for low cost, accurate analyses of most complex piping systems.
The M. W. Kellogg Company
225 Broadway, New York 7, N. Y.

STANLEY ENGINEERING COMPANY
CONSULTING ENGINEERS
Power Plants
Steam - Diesel - Hydro
Design - Construction - Test - Valuation
Surveys
Hershey Building — Muscatine, Iowa

The above consultants are available
to work out solutions
to your engineering and management problems.

He's using the telephone that lends an extra hand

"Sure . . . I'm looking up the figures right now!" From busy executives to clerks, people in business can work more easily and efficiently with Bell's new Distant Talking Telephone. Small white rectangle is the loudspeaker.

For people who want to keep *both* hands free when they telephone, Bell Telephone Laboratories engineers have devised a new telephone with a sensitive microphone in its base.

To use it, simply press a button. The microphone picks up your voice and sends it on its way. Your party's voice comes to you through a small loudspeaker. Both hands are left free.

The volume can be adjusted to suit yourself. If privacy is needed, you simply lift the handset; this shuts off the microphone and loudspeaker and you talk just as you would on a regular telephone.

This new development of Bell Laboratories increases the number of ways your local Bell telephone company can serve in businesses and homes.

Pencil points to microphone in base of new telephone. Left-hand button controls volume, center one turns set "on" and lights up while in use. The third is an "off" button.

Bell Telephone Laboratories

Improving telephone service for America provides careers for creative men in scientific and technical fields.

Index To Advertisers

*Aetna Ball & Roller Bearing Co. 7
Air Conditioning Exposition 47
*Air Preheater Corp. 116
*Allegheny Ludlum Steel Corp. 94
Allen-Bradley Co. 55, 56
*American Blower Corp. 98
*American Brass Co. 45
*American District Steam Co. 95
*American Felt Co. 6
American Flexible Coupling Co. 4, 5
ASME Publications 46, 84
*Armstrong Machine Works 97
*Associated Spring Corp. 17, 18
Aurora Pump Co. 42

*Bailey Meter Co. 2nd Cover
Bell Telephone Labs. 123
*Blaw-Knox Co.
Grating Dept. 72
Bridgeport Thermostat Div.
Robertshaw-Fulton Controls 53
Brush Electronics Co. 20
Bundy Tubing Co. 99

Carrier Conveyor Corp. 19
*Chain Belt Co. 82
Char-Lynn Co. 111
Chiksan Co. 16
Cincinnati Gear Co. 43
Clearprint Paper Co. 111
*Cleaver-Brooks Co.
Boiler Div. 9
Climax Molybdenum Co. 126
*Columbia-Geneva Steel Div. 31, 89-91
Cone-Drive Gears Div.
Michigan Tool Co. 113
Copperweld Steel Co. 3
Coppus Engineering Corp. 81
Cunningham, M. E., Co. 74

*Denison Engineering Co. 26
DeZurik Shower Co. 104
Diamond Chain Co. (Inc.) 33
Dillon, W. C. & Co. 106
*Dresser Industries (Inc.)
Roots-Connersville Blower 71
Drop Forging Association 15
Dudek & Bock Spring Mfg. Co. 76

Eastman Kodak Co. 77
*Elastic Stop Nut Corp. of America 107
Ellison Draft Gage Co. 74
*Engineer Co. 50

*Farrel-Birmingham Co. 85
Fenwal (Inc.) 24
*Flexitallic Gasket Co. 39
Ford Instrument Co.
Div. Sperry Corp. 108
*Foxboro Co. 32
Fulton-Sylphon Div.
Robertshaw-Fulton Controls 53

*Garlock Packing Co. 57
General Radio Co. 83

*Hagan Corp. 8, 86
Heating & Ventilating Exposition 47
*Hyatt Bearings Div.
General Motors Corp. 121
*Hydropress (Inc.) 11

Imperial Tracing Cloth 112
Institute of Radio Engineers 61
International Nickel Co. 34
Irving Subway Grating Co. 25

Jenkins Bros. 78, 79
*Johns-Manville 2

Kellogg, M. W., Co. 115

Linear (Inc.) 23
*Link-Belt Co. 22
Little, Arthur D. (Inc.) 10
Lord Mfg. Co. 87
Lovejoy Flexible Coupling Co. 112
*Lummus Co., Fabricated Piping Div. 44
Lunkenheimer Co. 125

*Mercoid Corp. 112
Midwest Piping Co. 21
Mycalex Corp. of America 65

*National Airoil Burner Co. 63
New Departure Div.
General Motors Corp. 1
New York Air Brake Co. 12
*Nicholson, W. H. & Co. 51
Northern Blower Co. 68

*Pangborn Corp. 67
Parker White Metal Co. 30
*Peerless Pump Div.
Food Machy. & Chemical Corp. 70
Permutit Co. 3rd Cover
Philadelphia Gear Works 37
Pittsburgh Lectrodryer Corp. 92
*Powers Regulator Co. 28, 29

Read Standard Corp. 49
*Republic Flow Meters Co. 93
Research-Cottrell (Inc.) 58
Revere Copper & Brass (Inc.) 40
Robertshaw-Fulton Controls Co. 53
Rockford Clutch Div.
Borg-Warner Corp. 104
Rockwell Mfg. Co.
Nordstrom Valve Div. 101
*Roots-Connersville Blower Div.
Dresser Industries (Inc.) 71

Sanborn Co. 27
Spraying Systems Co. 76
*Syntron Co. 106

*Taylor Forge & Pipe Works 13
*Tennessee Coal & Iron Div. 31, 89-91
*Terry Steam Turbine Co. 14
Thomas Flexible Coupling Co. 62
*Timken Roller Bearing Co. 4th Cover
*Tube Turns (Inc.) 109, 110

*United States Steel Corp. 31, 89-91
*United States Steel Export Co. 31, 89-91

Vickers (Inc.)
Div. Sperry Corp. 88
Virginia Gear & Mach. Co. 37
*Vogt, Henry, Machine Co. 96
*Voss, J. H. H., Co. 106

Waldes Kohinoor (Inc.) 105
Walworth Co. 102
*Westinghouse Air Brake Co. 66
Williams Gauge Co. 69
Wisconsin Motor Corp. 59
*Wolverine Tube Div.
Calumet & Hecla (Inc.) 114

*Yarnall-Waring Co. 35

The asterisk indicates that firm also has product catalog in the 1955 Mechanical Catalog.

CONSULTING SERVICE . . . Page 122

Black & Veatch
Electrical Testing Labs.
Gilbert Associates (Inc.)
Harsa Engineering Co.
Hathaway, C. M.
Jackson & Moreland
Kellogg, M. W., Co.
Kendall, George H.
Kuljian Corp.
Loftus, Peter F., Corp.
Mast Development Co.
National Weld Testing Bureau
Peacock Corp.
Polachek, Z. H.
Reibel, Sidney
Sanderson & Porter
Sargent & Lundy
Sirrine, J. E., Co.
Stanley Engineering Co.

Advertisers in Previous 1954 issues but not in this issue

Acme Chain Corp.
Aero Research Instrument Co.
*Aldrich Pump Co.
All American Tool & Mfg. Co.
*Allis-Chalmers Mfg. Co.
*American Manganese Bronze Co.
American Pencil Co.
*American Pulverizer Co.
American Welding & Mfg. Co.
Anderson, V. D., Co.
*Ampiex Div. of Chrysler Corp.
Atlas Chain & Mfg. Co.

*Babcock & Wilcox Co.
*Barco Mfg. Co.
Barksdale Valves
Bellofram Corp.
Bellows Co.
Biddle, James G., Co.
Bigelow-Liptak Corp.
Boston Gear Works
Bruning, Chas., Co.
*Buell Engineering Co.
Byers, A. M., Co.
*Byron Jackson Co.

Carboloy Dept. of General Electric Co.
Carborundum Co.
Catalytic Combustion Corp.
Chace, W. M., Co.
Chapman Valve Mfg. Co.
Clarage Fan Co.
Clark Equipment Co.
Industrial Truck Div.
Clifford Mfg. Co.
*Cochrane Corp.
*Coffin, J. S., Jr., Co.
*Combustion Engineering (Inc.)
Commercial Shearing & Stamping Co.
*Consolidated Chimney Co.
Consolidated Engineering Corp.
Copper & Brass Research Assoc.
Cosa Corp.
Cuno Engineering Corp.

Detroit Harvester Co.
Pioneer Pump Div.
*Detroit Stoker Co.
Diamond Power Specialty Corp.
Dow Corning Corp.
*Downingtown Iron Works
DuMont, Allen B. Labs.

Eagle Pencil Co.
Edward Valves (Inc.)
Sub. Rockwell Mfg. Co.
Engineered Precision Casting Co.
*Erie City Iron Works

Fafnir Bearing Co.
Fairbanks, Morse & Co.
*Falk Corp.
Fiske Bros. Refining Co., Lubriplate Div.
*Flexonics Corp.
*Foote Bros. Gear & Machine Corp.
*Gear Specialties (Inc.)
General Electric Co.
Gerotor May Corp.
*Goulds Pumps (Inc.)
Graphite Metallizing Corp.
*Grinnell Co.

Hamilton Mfg. Co.
Helicoid Gage Div.
American Chain & Cable Co.
Higgins Ink Co.
*Hoffman Combustion Engrg. Co.

*Illinois Gear & Machine Co.
Instrument Society of America
Instruments Publishing Co.
International Correspondence Schools
Iron Fireman Mfg. Co.

*James, D. O., Gear Mfg. Co.
Johnson, Carlyle, Machine Co.
Joy Mfg. Co.

Kennametal (Inc.)
Keuffel & Esser Co.
*Kewanee-Ross Corp.
Key Co.
Koppers Co.
Fast's Coupling Dept.

*Ladish Co.
Lefax
Lenape Hydraulic Pressing & Forging Co.
*Leslie Co.
Lincoln Electric Co.
Lonergan, J. E. Co.
Lubriplate Div.
Fiske Bros. Refining Co.
MB Mfg. Co.
*Martin-Rockwell Corp.
Marsh, James P., Corp.
Miehle-Dexter Supercharger Div. of Dexter Folder Co.
Morse Chain Co.

Nagle Pumps (Inc.)
National Acme Co.
National Valve & Mfg. Co.
Niagara Blower Co.
Nugent, Wm. W. & Co.

Ohio Gear Co.
Ohio Injector Co.
*Oilgear Co.
Olson, Arthur A. & Co.
O'Neil-Irwin Mfg. Co.

Pacific Pumps (Inc.)
Peerless Photo Products
*Pennsylvania Pump & Compressor Co.
*Pesco
Pittsburgh Piping & Equipment Co.
*Posey Iron Works
Powell, William, Co.
Princeton University Press

Reliance Electric & Engrg. Co.
Reliance Gauge Column Co.
Resolite Corp.
Rio-Wil Co.
Ronald Press Co.
Rotary Seal Co.
Roth Rubber Co.
Rust-Oleum Corp.
*Sarco Co.
*Schutte & Koerting Co.
*Seamless Co.
Servel (Inc.)
Sheffield Co.
*Spence Engineering Co.
Sparta Mfg. Co.
Streeter-Amet Co.
Sturtevant, P. A., Co.
Synchro-Start Products

Taylor Dynamometer & Machine Co.
*Taylor Instrument Cos.
Thompson-Bremer & Co.
Thompson-Leonard, John, Ltd.
Titusville Iron Works Co.
Div. of Struthers Wells
Trabon Engineering Corp.
Trane Co.
Trimount Instrument Co.

*U.S. Hoffman Machine Corp.
Waterman Engineering Corp.
*Western Gear Works
*Westinghouse Electric Corp.
Wheeler, C. H., Mfg. Co.
*Wickes Boiler Co.
Div. of Wickes Corp.
Wiegand, Edwin L., Co.
Wiley, John & Sons
*Wing, L. J., Mfg. Co.
Winsmith (Inc.)
Winzeler Mfg. & Tool Corp.

Yoder Co.

*Zallea Brothers
Zurn, J. A., Mfg. Co.

take advantage of LUNKENHEIMER Quality

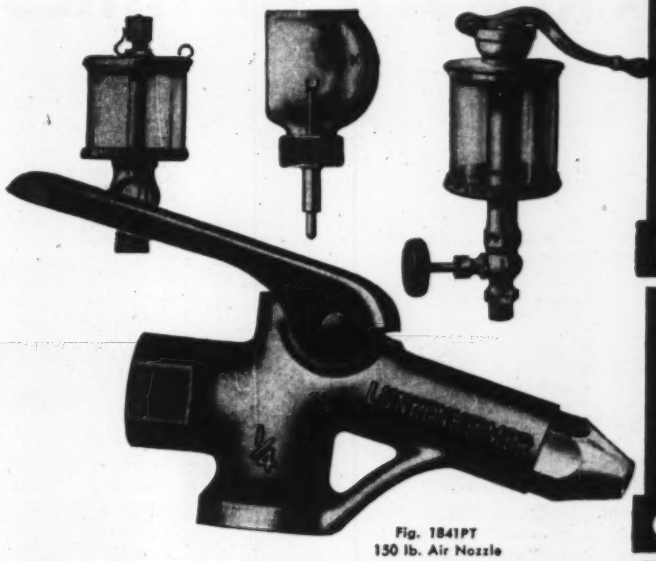
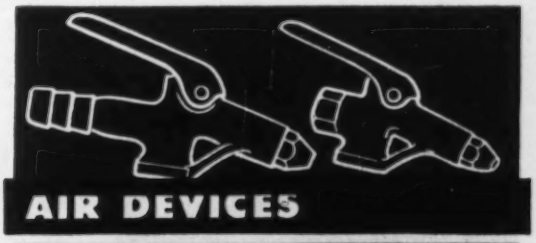
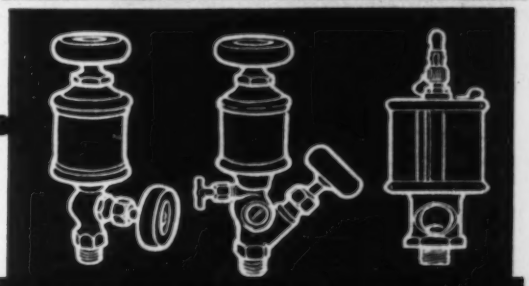


Fig. 1841PT
150 lb. Air Nozzle



AIR DEVICES



LUBRICATORS

OIL AND GREASE CUPS

Make your expensive machinery last longer with Lunkenheimer Lubricating Devices. Cut the high cost of compressed air leaks with Lunkenheimer Air Nozzles and Cocks. Keep accurate check on your storage tanks and reservoirs with Lunkenheimer Liquid Gauges. All these carefully designed, carefully cast, carefully machined bronze accessories assure *longer* wear with *less* repair. The complete Lunkenheimer Line includes oil cups, grease cups, lubricators, cocks, nozzles, liquid gauges, and whistles. See your Lunkenheimer Distributor, or write for literature to The Lunkenheimer Co., Box 360K, Cincinnati 14, Ohio.

BRONZE. IRON. STEEL

Yes, Lunkenheimer produces the highest quality Engineering Devices, as well as the world's finest valves. And today — with the high cost of maintenance growing still higher—you NEED the extra margin of quality in design and workmanship that has made Lunkenheimer products world-famous.

LUNKENHEIMER
QUALITY

The Cost of a Lunkenheimer Valve Gets Smaller and Smaller and Smaller with Every Passing Year of Dependable Service.

LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES

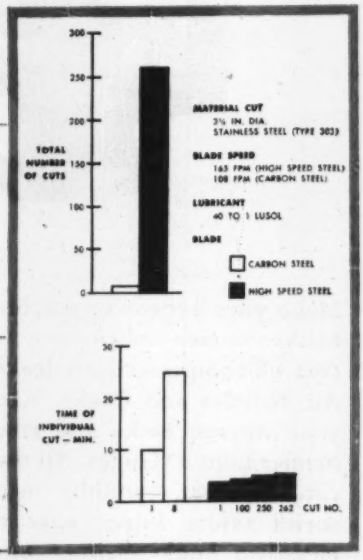
Why Moly alloy steels are in your future

CUTTING LIFE INCREASED 10 TIMES

with

Moly tool steels

the part	**BAND SAWS**
the problem	Carbon-steel band-saw blades are usually made of a tool steel with about 1.25% C. For normal usage band saws make smoother and straighter cuts than hack saws. However, normal band saws run into difficulties when they're used as cut-off saws for materials with different machining properties.
the pay-off	The Henry G. Thompson & Son Company developed a moly high-speed steel, cut-off band-saw blade for stainless steel and other materials on a production basis. The chart shows graphically the results: cutting life of saw increased, time per cut shortened.



If you make, use, specify or buy steels you need a copy of "ALLOY STEELS PAY OFF"

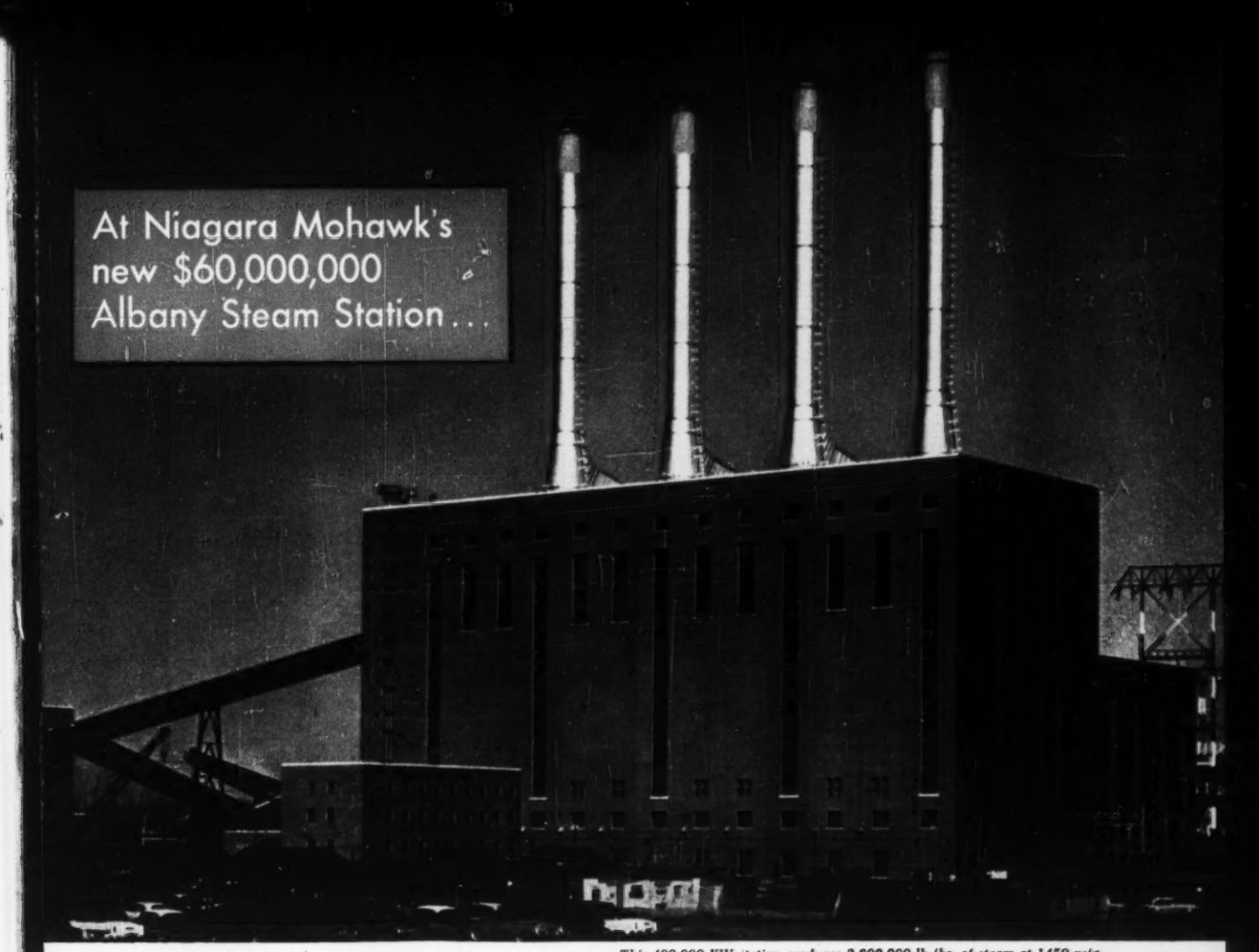
Such topics as:

air valve stems on coal washers, anchor chain, annealing retorts, ball cages in universal joints, band saws, bolts, boring bars, bridges, bumpers for passenger cars, cable-tool and churn-drill bits, caustic evaporators, centralization feed pumps.

This big, fully documented 207 page book gives more than 50 complete case histories of alloy steel usage . . . such as outlined above. And each case history is an *idea*-starter of its own! Everything from "ANNEALING RETORTS" to "TRIMMER BLADES". Get your copy today. Address Dept. 9, on your letterhead, please. *Climax Molybdenum Company, 500 Fifth Avenue, New York 36, N. Y.*

This advertisement is printed in one shade of molybdenum orange, a pigment widely used for its striking color and good coverage — ideal for paint on industrial equipment . . . brings high visibility that means extra safety.

CLIMAX MOLYBDENUM



This 400,000 KW station produces 2,600,000 lb./hr. of steam at 1450 psig.

Permutit Demineralizers deliver highest quality make-up... and save money, too!

Albany Station's Mixed-Bed Demineralizer was guaranteed to produce make-up of not over 0.5 ppm total solids (about 1 micromho in conductivity), silica of not over 0.1 ppm. It is consistently delivering *better* make-up—0.1 to 0.3 micromhos in conductivity, silica of 0.03 ppm.

Operators are enthusiastic! They like the availability of this Permutit Demineralizer. It is independent of the heat cycle—supplies plenty of make-up for filling a boiler after a shutdown, delivers water at low loads when evaporators would not be available.

Automatic Regeneration saves money! High-capacity Permutit ion exchange resins require fewer regenerations. Motor-driven valves automatically backwash and separate the two resins, individually regenerate and rinse the beds, evenly blend the resins and return the unit to service. Operators have only to keep charges of regenerating chemicals ready.

For performance and cost data on this installation or aid in solving your water problem, write The Permutit Company, Dept. ME-12, 330 West 42nd Street, New York 36, N. Y., or Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

WATER CONDITIONING HEADQUARTERS

PERMUTIT®

Completely new Bullard Cut Master V.T.L. Model 75 uses TIMKEN® bearings to insure extra load capacity, top precision

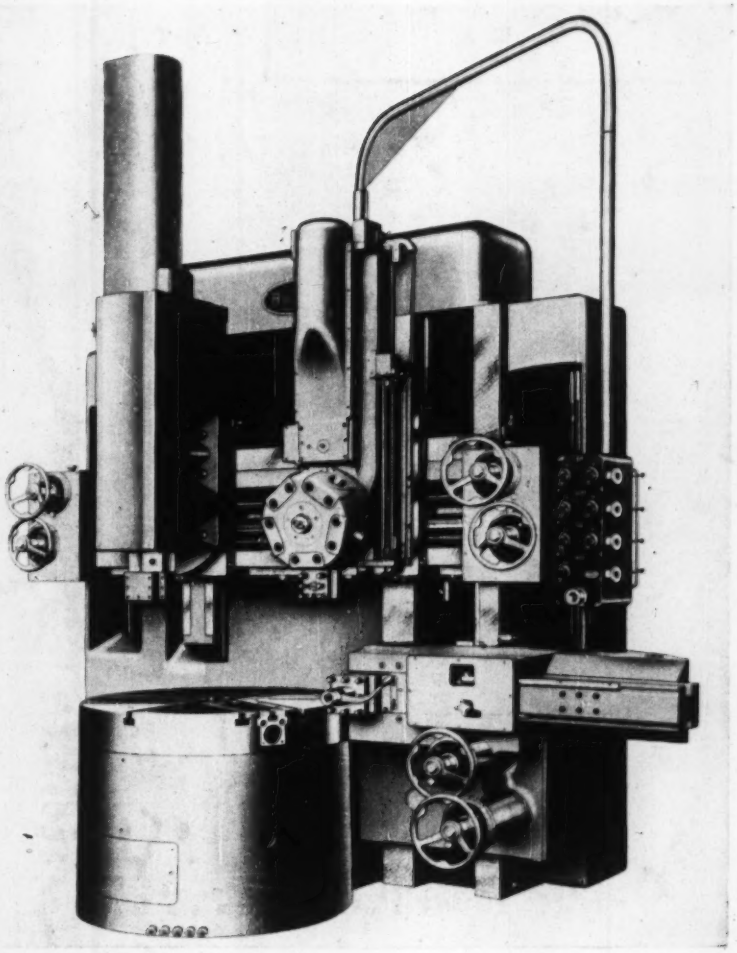
TO reduce power losses and provide highest efficiency at point of cutting, The Bullard Company engineers chose Timken® tapered roller bearings for the Bullard Cut Master Model 75, a completely new design of vertical turret lathes. Timken bearings are used in the table, headstock, feed and traverse mechanism, side, ram and turret head drives and other applications throughout the machine. They have been selected to meet the service requirements at each vital point with maximum efficiency. From 160 up to 196 Timken bearings are used according to the number and types of heads selected.

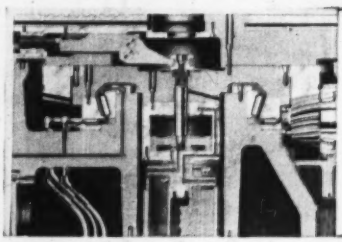
Timken bearings have extra load-carrying capacity that results from line contact between rollers and races. Tapered construction permits preloading, so deflection is kept to a minimum, and constant accuracy is maintained. Radial and thrust loads can be carried in any combination. Timken bearings are geometrically designed to roll true and precision manufactured to live up to their design. They hold shafts in rigid alignment, insure accurate gear mesh.

We take every step possible to make Timken bearings the best. We even make our own steel so we can control quality from beginning to end. We're the only U.S. bearing manufacturer that takes this extra step.

Make sure the machines you build or buy have bearings with the trademark "Timken". They're number one for value. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best



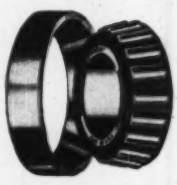


BULLARD design of table bearing construction uses Timken tapered roller bearings for long life, trouble-free performance.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ◯ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭

BEARING TAKES RADIAL ◫ AND THRUST ←◫→ LOADS OR ANY COMBINATION ✳